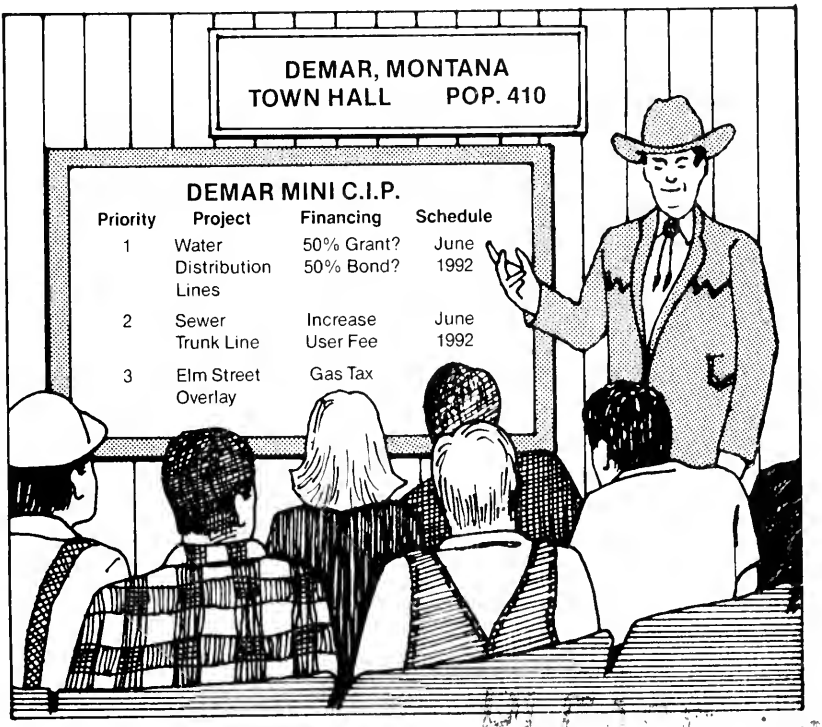
THE MINI CAPITAL IMPROVEMENTS PLAN FOR SMALL TOWNS

SECOND EDITION

Saving Money by Efficient Planning, Depreciation, and Financing of Community Water, Sewer and Street Improvements



June 1992

MONTANA DEPARTMENT OF COMMERCE
Community Development Block Grant Program
Community Technical Assistance Program

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FOR SMALL TOWNS

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SAVING MONEY BY EFFICIENT PLANNING, DEPRECIATION
AND FINANCING OF COMMUNITY WATER, SEWER
AND STREET IMPROVEMENTS

JUNE 1992

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FORWARD

This handbook is one of the many efforts of the Montana Department of Commerce to assist Montana's local governments to finance, build and maintain public works facilities. Sound public facilities are essential to a community's growth, prosperous business environment, and quality of life.

This document is written for the non-engineer, and is intended to provide local officials and public works directors for small towns and county water/sewer districts with a straightforward description of the capital improvement planning and budgeting process. The end product of the process, the **Five-Year Mini Capital Improvements Plan,** provides the essential tool to evaluate local needs, identify priorities objectively, identify costs and funding sources, and ultimately, schedule construction projects.

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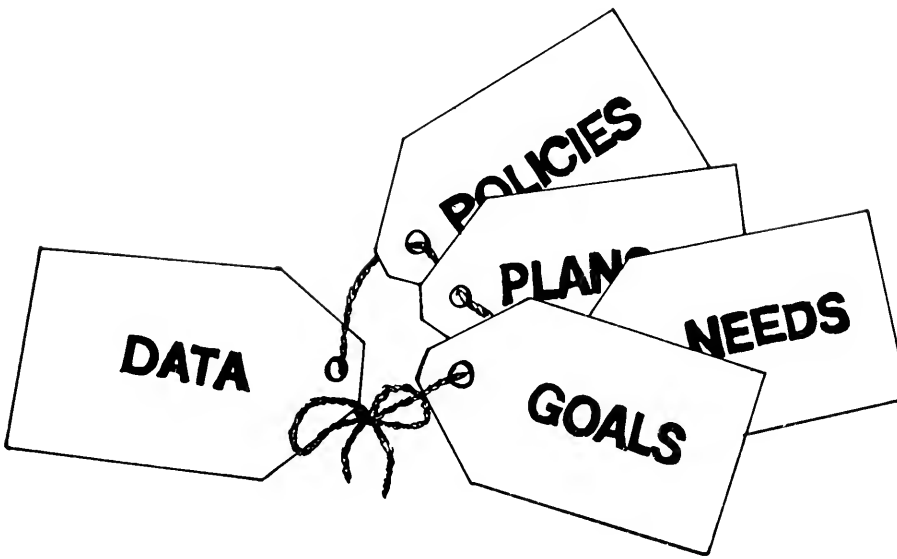


SCOPE OF THE PROBLEM

In 1991 the Montana Department of Health and the Montana Department of Commerce estimated that there is an immediate need of:

* $268 million dollars for community water system rehabilitation in Montana
* $132 million dollars for community wastewater system rehabilitation in Montana
* $8.0 billion dollars for county and city roadway rehabilitation in Montana

The above estimates are based on available data. Some of these figures are rough estimates. In reality, the financial needs are much higher because information does not exist for many local water, wastewater, and street systems.

There is an overwhelming demand for shrinking state and federal grant dollars. A distressed economy and lack of aggressive financial planning further add to a problem that has reached staggering proportions. Only with better financial planning and aggressive public education will Montana local governments be able to maintain financial solvency and adequate service capabilities. The cost may be high but cannot be ignored. It will not go away or get cheaper.

WHO SHOULD USE THIS HANDBOOK?

This handbook is primarily designed for use by:

* Small towns (municipalities under 10,000 in population) that need to make water, sewer, and street repairs and improvements; and
* County Water and Sewer Districts in rural areas that need to make water or sewer repairs and improvements.

In addition, county governments that need to make road improvements and set up capital improvement plans may find some parts of this handbook useful.

Written in layperson language wherever possible, this handbook discusses the water, sewer, street repair and improvement planning and financing methods so that your town or district can create a simple capital improvements plan (financial plan). Specifically, the following individuals will want to review this handbook as an aid to help them with planning and financing improvements: governing body, clerk and financial staff, public works director and maintenance staff, planning director, consulting engineer, and other consultants such as accountants or grant writers.

WHAT IS THE PURPOSE OF THIS HANDBOOK?

The purpose of this handbook is to set forth a step-by-step procedure which can be followed by small communities to develop a capital improvements plan for sewer and water facilities and streets.

WHAT IS A CAPITAL IMPROVEMENTS PLAN?

A Capital Improvements Plan (CIP) is a budgeting and financial tool used by a local governing body to establish public works rehabilitation and maintenance priorities and to establish

funding for repairs and improvements. The CIP includes planning, setting priorities, effective public works management, financial management, and community decision making.

A CIP consists of five basic elements:

1. inventory and evaluation of existing conditions for each facility (needs assessment);

2. prioritization of improvement needs for each public facility and prioritization of the needs for the entire infrastructure;

3. identification of monetary options that can be used to meet the needs;

4. establishment of a time schedule that matches available funds to the improvements required to meet the system needs; and

5. a brief written document (the CIP) which is formally adopted by the governing body by resolution or by ordinance.

A community's CIP normally covers all public works: streets, water, sewer, bridges, drainage, parks, public buildings, etc. This handbook sets forth a method to establish a "Mini CIP", focusing only on the street, sewer, and water facilities. These three facilities are normally the most expensive facilities. They are subject to intense regulation and are the most time-consuming to administer. For communities that have a desire to reap the benefits of a full CIP, the Department of Commerce has additional materials available which explain the procedure.

WHY SHOULD A LOCAL GOVERNMENT HAVE A CAPITAL IMPROVEMENTS PLAN?

1. To save money.

2. To improve effectiveness of government expenditures.

3. To understand and respond to citizens' needs and desires.

4. To obtain community understanding and support for critical projects. Citizen participation helps generate support for making public facility repairs.

5. To encourage economic development. New businesses need, adequate water, sewer, parking, and street access. A CIP provides for these facilities.

6. To prevent public works crises. With a CIP, government officials are made aware of what needs to be done, how much it costs, when it needs to be done. Most crises can be prevented with a CIP.

7. To encourage consensus which will reduce administrative delays and conflicts because there is agreement on the scope of work, timing, and responsibilities.

8. To help a governing body set up a stable financial plan to meet public works needs, thus ensuring financial stability. A CIP demonstrates to bond underwriters that the local government is a better financial risk.

9. To help improve your chances for obtaining grants. For example, both the Community Development Block Grant Program and the Economic Development Administration programs give grant applicants extra credit for having a CIP.

10. To help the governing body provide direction to its own staff and consultants.

A CIP compels local staff to thoroughly justify each project request.

11. To prompt a rigorous analysis of all financial options. This analysis may help the local government to uncover financing options which can help stretch tax dollars and save money.

12. To take unreasonable pressure from the governing body to fund a project that a small group thinks is important. A CIP helps to prevent funding "pet projects."

13. Having a CIP allows you to use the local government "CIP Fund." This fund is essentially a type of reserve account or "savings account" for paying for your capital improvements plan (7-6-2219, MCA, Counties; 7-6-4134, MCA, Municipalities).

14. The Department of Commerce Certified Cities Program encourages communities to have a CIP. (Certified Cities designation can help you create more jobs in your community).

CAN COST SAVINGS BE REALIZED FROM A CIP?

A CIP is a cost savings tool in that it identifies where improvements will be needed over time rather than waiting for each crisis to occur before taking action. It is usually more expensive to make emergency repairs than it is to maintain a system in working order by foreseeing problems and making corrections before there is a total breakdown in the system.

Since there is never enough money to meet all needs, the CIP assists the governing body in establishing priorities for funding projects from different types of facilities. For example, a town council is faced with a decision as to whether to fund the paving of Elm Street this year or to fund the repair of the ailing sewage lift station on Jackson Street. A CIP provides the council with information on which project is most technically critical and which is most economical. Thus, money is allocated in the most effective way with an eye to avoiding major breakdowns or crises.

MONTANA CASE STUDIES OF CIP COST SAVINGS

The following are some examples of Montana communities that have used the CIP process to reduce the cost of community facility improvements.

ABSAROKEE (Population 800).

The unincorporated town of Absarokee, Montana prepared a CIP in 1983. John Beaudry, the CIP Coordinator, explained: "One of the most critical needs identified was the need to repair the sewer system. The Town's engineering firm proposed a 1 million dollar design, with an estimated annual operating cost of $30,000. Because the CIP process stresses looking at alternatives for funding, doing the CIP helped the town find (rare) 100% grant funding for sewer construction. Thus, the CIP helped the local citizens save $1 million. The CIP process also helped the town discover a way to cut the annual operating cost of the new system from $30,000 to $10,000 - saving the citizens $20,000 each year."

SACO (Population 240).

The Town of Saco, Montana prepared its first CIP in 1984. According to the Town's consultant Barbara Richard: "Among other things, doing the CIP forced the Town to do an in depth assessment of the water system. We had to look at all repair and financing alternatives, thus, we were able to choose the most cost efficient alternatives. When we

studied the leaky axillary water tank, we were faced with the decision of whether we should repair or replace the tank. The analysis done as part of the CIP showed that we could repair the tank for $30,000 and get enough years of additional service to make repair cost effective. Replacing the tank would have cost $60,000 - $90,000. The CIP analysis helped us choose the option of repairing the tank, thus saving the towns people $30,000-$60,000. Because the CIP process helped us to identify this project and to study the various financial options, we found we could budget part of our water reserve fund over a several year period to pay for the repair."

WHAT IS THE RELATIONSHIP BETWEEN ENGINEERING MASTER PLANS AND THE CIP?

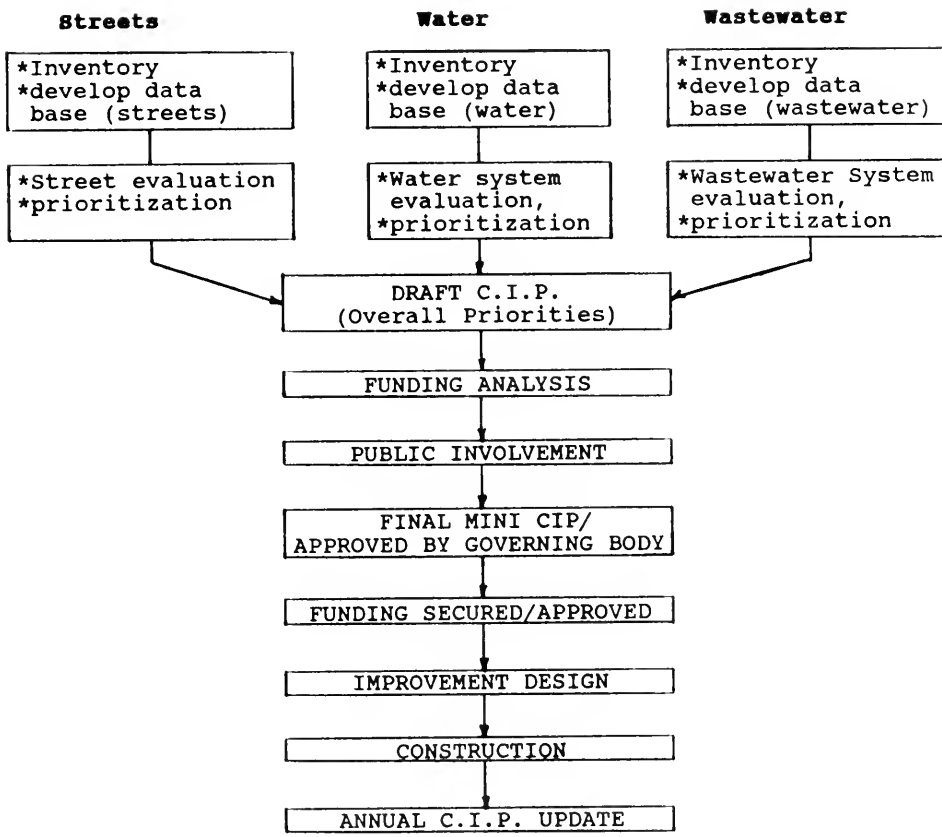
An engineering master plan is a detailed analysis and pre-design tool for a public works facility. The master plan is a systematic evaluation which proposes a comprehensive solution to meet local needs. The engineering plan is a more detailed technical analysis, it is not a budgeting or financial tool.

A CIP is a budgeting and financial tool that is used by the governing body of a local government to set public works priorities from a financial perspective. If possible, the CIP is based on an engineering master plan for each facility discussed in the CIP.

Unfortunately, due to lack of funding, many small communities do not have an engineering master plan for each public facility. Yet, the governing body still must budget money every year for public works repairs and replacement. Realizing this dilemma, this handbook provides sound but practical analytical methods to identify needed improvements and begin the budget process to fund detailed plans, repairs, and construction.

The Mini CIP planning process should generally follow the steps shown on Figure 1-1. The process is briefly explained below.

FIGURE 1-1
MINI CIP PLANNING PROCESS



CAPITAL IMPROVEMENTS PLANNING PROCESS SUMMARY
Inventory, Evaluation, Setting Priorities, Funding, Public Education

The development of a Mini CIP requires that certain information for each community facility be collected and assembled in a form that can be entered into the CIP process. The information is generally available at the community level and can be assembled by local government using existing staff or part-time help. A summer intern with an engineering background could be employed to collect and tabulate the data.

The following process is used to develop a Mini CIP:

1. Inventory - Functional Classification of the Three Systems

This item consists of the preparation of a map breaking the three systems into segments and showing the basic function of each segment. For example, the segments of the three systems could be described as follows:

A. street system - arterial streets, collector streets, local access streets

B. sewer system - treatment, trunk line, collectors

C. water system - treatment, transmission line, distribution, pumping

The functional classification breaks each system down into segments so that each segment can be designed for its specific function and a data base can be constructed. For example, arterial streets are designed to carry traffic with a minimum of conflict from cross streets. Local access streets are designed for slow speeds and provide direct access to abutting properties.

2. Evaluation - Condition of The Three Systems

Each system must be evaluated to identify the relative condition of each segment. This can be a costly process, depending on the detail required. This manual sets forth basic procedures to identify major system deficiencies. Detailed technical system analysis will require the use of a professional engineer with the expertise and resources required to carry out a detailed condition analysis. At some stage it may be necessary to prepare a full engineering master plan for the street, sewer, and water systems. Evaluation also means looking at potential public health threats and compliance with state and federal regulations.

3. Set Improvement Priorities

Improvement priorities for each system are developed by analyzing the information from Step 1 and 2 for the three systems. Overall priorities for all 3 systems are then established.

4. Develop Cost Estimates for Improvements

Preliminary cost estimates for improvements identified by the condition analysis are made using estimated bid prices from local contractors. Due to the general nature of the condition analysis, these cost estimates are not accurate enough to be used as a definitive basis for estimating the cost of a specific improvement project, but are acceptable for budget level estimates.

5. Funding Research and Analysis

The research and identification of funding sources and options to finance improvements to each system is one of the most difficult tasks of developing a CIP. Due to ongoing changes in federal and state funding programs, it is only possible to forecast funding availability from these sources for short time periods when budgets are known. For this reason, the current level of funding, from state grants and loans, federal grants or loans, and user fees is assumed to be the same for the duration of the CIP.

6. Public Involvement and Education

Public support of the CIP is the most essential step in the entire planning process. A draft CIP document or chart must be prepared and distributed to the media and the public. A variety of methods must be used to educate the public about the repair and improvement needs.

7. Governing Body Adopts CIP

The governing body must formally adopt the CIP by resolution or ordinance. A "final" CIP document or chart must be prepared and attached to the commmunity's annual budget document.

8. Secure Funding

This may include applying for and receiving state or federal grants and loans, raising user fees, issuing bonds, creating SID's, and carrying out other local government financing methods.

9. Construct Improvements

Now that the money is in hand, the scheduling and management of the construction or repair projects may begin.

10. Annual Update of CIP

The CIP should be updated each year prior to approval of the annual budget. Attach the updated CIP to the annual budget document.

ROLES AND RESPONSIBILITIES: WHO DOES WHAT IN THE MINI CIP PROCESS?

The composition and needs of each local government will vary. The following is a summary of the role of each of the key officials and participants often involved in the capital improvements planning and financing process:

1. **Governing Body (City council or county commissioners or county water/sewer board)** - Makes policy decisions, financial decisions and management decisions. Directly represents the voters. Has the responsibility to involve the general public in the discussions regarding proposed improvements. For small municipalities in particular, the mayor is a key figure because he directly supervises the staff, manages town issues, and formally represents the town on public facility improvement matters.

2. **City Manager** - Unfortunately, most small towns and water/sewer districts do not have managers. In larger cities (and counties), the manager usually serves as the CIP coordinator. The manager prepares budgets and financial proposals and proposes new methods to improve the effectiveness of the government.

3. **Lead Financial Researcher (Typically, the CIP Coordinator in Small Towns)** - Investigates and analyzes financial options to pay for improvements. For many small communities, serves as overall coordinator for preparing and carrying out the CIP. For small incorporated cities and towns, this person is usually the city clerk. For county water/sewer districts, this person may be someone on the board. This person may be a financial consultant.

4. **Engineering Consultant** - Provides engineering and facility management expertise. Designs complex major improvements, such as water and sewer treatment plants. Some firms may also provide financial, planning, grant writing and related services. Small towns typically contract with an engineer to provide part time assistance.

5. **Public Works Director or Maintenance Superintendent** - Operates, maintains, repairs and replaces the community's public facilities. Conducts analysis of water, sewer, street and other needs. For many small communities, is responsible for carrying out the repairs in the CIP. Works closely with the consulting engineer.

6. **Local Government Attorney** - Clarifies legal requirements. If necessary, prepares Public Service Commission (PSC) rate cases (for municipalities only).

7. **Planning Board and Planning Director** - Advises the governing body and the CIP coordinator regarding the relationship of proposed public works improvements to the comprehensive plan (the overall plan of development and conservation for the community). A CIP and individual improvement projects may be used to carry out the development goals of the comprehensive plan (see 76-1-601(4), MCA). If the town or county has a professional planning director, that person is sometimes asked to serve as the Mini CIP coordinator.

8. **Bond Counsel** - If bonds will be used to finance improvements, bond counsel prepares the issue so that the bonds are legally correct and marketable.

9. **Grantwriting Consultant** - Prepares complex grant and loan application packages. Often administers projects if grants are awarded. Some towns handle grantwriting with local staff, some contract out this function to a consultant.

The role of the CIP Coordinator is critically important. Someone (the coordinator) has to be in charge of pulling everything together from the many persons involved in the process. The coordinator has to make sure the work gets done.

The CIP Coordinator serves as a troubleshooter, particularly when problems with financing occur. There is no pat answer as to who should be the Coordinator. The governing body should formally designate the Coordinator after careful consideration of who has the appropriate management, planning and financial skills to handle the job. If a consultant is chosen for the post of coordinator, the governing body must still supervise the consultant and make the final policy decisions.

Most local governments find that a team approach to preparing and carrying out the CIP is most effective. Typically, a committee of the key officials, staff, and consultants compose the team.

THE TOWN'S COMPREHENSIVE PLAN, LAND USE REGULATIONS, AND THE PLANNING BOARD

Local officials need to think about the "big picture" before they make major improvements to a town's water system, sewer system, and streets. The town's comprehensive plan, zoning regulations, and subdivision regulations are part of the big picture. The planning board advises the governing body on these things. Does your town have a planning board? If so, get the planning board involved in the preparation of the Mini CIP. (If you don't have a board, you many want to call the Department of Commerce Community Technical Assistance Program at 444-3757 for information on the benefits of forming a planning board).

Small towns benefit from having a planning board and preparing and updating a comprehensive plan. A comprehensive plan is a written statement or "blueprint" of how the citizens think the town should develop in the future. The plan provides advice on how to make the town more beautiful, more efficient and a safer place to live. The plan suggests which lands should be developed and which buildings could be improved. The plan also provides advice on which lands and buildings should be preserved in their present state. Montana law says that comprehensive plans can include a suggested long range development program for public works such as water, sewers, and streets. Knowing the desired development pattern for the town, as stated in the comprehensive plan, is very important before local officials undertake major water, sewer, or street improvements.

The Mini CIP can be an important tool to help the town carry out it's comprehensive plan. For example, if new business development is wanted in one part of town, such as the downtown retail district, the Mini CIP can propose that upgraded water and sewer lines will be provided to stimulate and service new development in the downtown. For example, many small towns do not have central water or sewer systems. In one of these towns no construction of any kind can occur because of failing individual septic tanks and the potential for polluted wells. The only way that private property owners will ever be able to make improvements to their houses and businesses is for the town to install central water and sewer systems. For the town to succeed in carrying out its comprehensive plan of community improvements, central water and sewer systems will first have to be installed.

A comprehensive plan can also help with the preparation of the Mini CIP because a comprehensive plan includes population projections for the town. To compute the sizes of new water and sewer mains and treatment plants, the engineers or designers need to know how big the population will be in the future. Whether the population is growing, declining or stagnant is also important for figuring out how much each resident will pay for the improvements, now and over the next few years.

It is important to consider how your Mini CIP relates to your zoning regulations. For example, if you are improving sewer lines through a residential neighborhood that is zoned "single family residential use," you would not want to oversize the lines. Oversized lines are an invitation for developers to suggest rezoning of the neighborhood for apartments or commercial development that may disrupt the quiet nature of the neighborhood. This usually leads to intense disputes between the developers and the existing neighborhood residents, with the local government officials caught in the middle. Local officials have found out to their dismay that zoning can not usually control the development pressure that oversized sewers unleash.

Another relevant issue in planning improvements is the ultimate population density specified or implied by the community's zoning ordinance. This is called the "build out density." The build out density is simply the total number of buildings that would be built if all vacant lots and lands are developed. It is important to look at the build out density to estimate the number of new water and sewer hookups needed, as well as the new capacity needed for the water and sewer treatment plants.

Your community's subdivision regulations have a relationship to water and sewer improvements. New housing subdivisions will need water and sewer facilities. Does your community want these new neighborhoods on central water and sewer facilities? Is there enough treatment capacity to handle more subdivision activity?

In summary, if you have a planning board, get them involved to help you look at the bigger picture. (Note: For unincorporated communities the county water and sewer district representatives should seek the assistance of the county planning board and staff). If you don't have a planning board, the governing body and the staff should at least discuss these issues before making major water, sewer, and street improvements. One helpful reference book on this topic is Land Use and the Pipe, Planning for Sewerage written by Richard Tabors, Michael Shapiro, and Peter Rogers (Lexington, MA: Lexington Books, D.C. Heath and Co., 1976).

THE VALUE OF POLICIES IN DEVELOPING THE MINI CIP

A local government should establish management policies that guide the Mini CIP process. Policy guidelines are a reflection of overall community goals and objectives related to future growth and development and fiscal capacity. Policies are very useful because they provide long-term guidance on how day to day decisions should be made, so that the daily decisions conform to long-term and overall community needs or desires. Decision makers need to take the time to ask themselves questions about where their community is going, how they are going to get there, and how funds will be allocated to do this. The Planning Board should be part of this process because it is their responsibility to make recommendations regarding land use, zoning, and comprehensive planning that should be compatible with and coordinated with CIP policies.

Public works policies can span the range from fiscal policies concerning indebtedness, to management policies relating to proper maintenance and operation of a facility. Some categories of policies include fiscal policies, policies on allocating costs, policies on how to finance capital projects, policies on extension of water and sewer mains, and policies on planning construction management. Some specific examples of policies a local government might develop include:

* Our local government will indebt itself for facility replacement only to 50% of the statutory maximum.

* We will make water, sewer, and street improvements to encourage redevelopment of run-down areas in town.

* Municipal water and sewer will only be provided to areas that are in the municipal limits or are to be annexed into the municipality.

NEED FOR ENGINEERING SERVICES

There are limitations to the Mini CIP. However, even without an engineering master plan, the Mini CIP process enables the local government to:

1. Develop and retain historical repair and maintenance costs.

2. Perform an inventory and analysis of your water system, sewer system, and streets (with the exception of very technical water treatment analysis and wastewater treatment analysis).

3. Develop general cost estimates for annual in-house replacement efforts, for objective prioritization of improvements, and for financial planning.

4. Develop public education and information programs to show the need for funding public works needs.

Much of the needs analysis in the CIP process can be done by the local public works director or maintenance supervisor; however, some analysis may require a professional engineer. Communities are urged to work with a qualified professional engineer on needs or problems that local staff cannot handle.

If your community needs to hire an engineer, the following organizations can help:

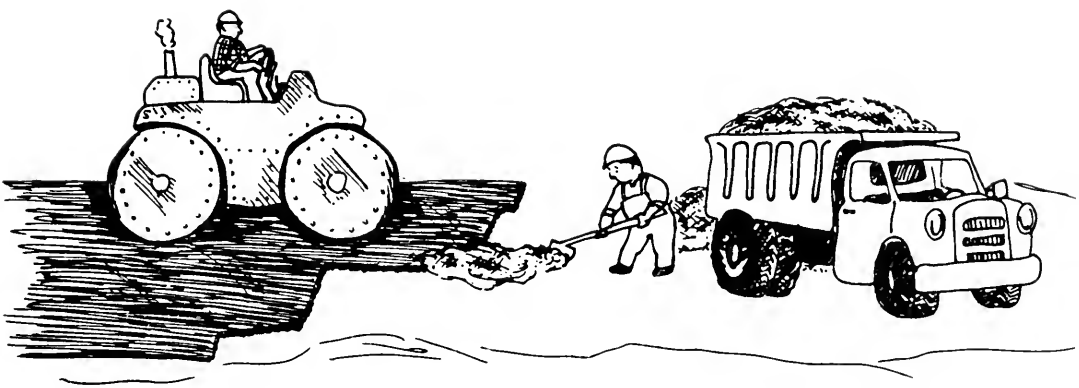
1. The Midwest Assistance Program (MAP) publishes a booklet titled "How to Hire an Engineer". To get a copy, call MAP at 862-3600 or 273-0410.

2. The Department of Commerce, Community Technical Assistance Program (CTAP) publishes a booklet on how to hire consultants, including engineers, titled "Working With Consultants". To get a copy, call CTAP at 444-3757.

3. The Rural Technical Assistance Program (RTAP) at Montana State University can help local governments which need to contract for services through peer review. As a neutral party, RTAP can eliminate the misunderstandings between local governments and their engineers and contractors. RTAP uses the American Society of Consulting Engineers Standards on how to hire engineers. For further information contact RTAP at 994-6100 or 1-800-541-6671.

CHAPTER TWO

STREET SYSTEM NEEDS ANALYSIS



OVERVIEW OF CHAPTER

Street and road maintenance in Montana is largely the responsibility of local government. Of the State's 78,000 miles of streets and roads, 70,000 miles are the responsibility of local government. The Governor's Infrastructure Committee in 1984 estimated local government's share of bringing streets and roads to current standards is $8 billion dollars. Adequate funding for local roads is very difficult to obtain due to the Montana property tax freeze and cuts in state and federal funds.

The competition for limited grant funds, coupled with limited local funding options, makes capital improvements planning a necessity. All improvements must be well justified and prioritized in order to be funded through grants or local financing methods. The following analysis can help your local government stretch whatever money can be raised for street repair and replacement.

BENEFITS OF CONDITION ANALYSIS

Often street maintenance needs are determined by answering complaints in the order they are received or by driving streets and making a list. While these methods work, they lack an objective base of standards for comparing relative needs. The condition analysis allows the local staff to judge the relative condition of streets and to set priorities for performing improvements based upon consideration of the entire street system. Also, using the condition analysis method allows a local government to identify which streets to repair before irreversible crown or base damage occurs. Delaying repairs to a street which needs an overlay will cost the taxpayers up to 10 times as much money (because of the higher cost of reconstruction compared to an overlay).

HOW TO DO STREET CONDITION ANALYSIS

The following is a step-by-step outline of the condition analysis procedure. This is a model based on a proven system. However, your engineer or a public works director may recommend an alternate system which is more appropriate to the needs of your community.

STEP 1. ASSEMBLE MATERIALS AND EQUIPMENT REQUIRED TO CARRY OUT CONDITION ANALYSIS

The following materials and equipment will be needed to carry out the condition analysis:

1. Street System Map - a current street map at a scale of 1 inch = 100 feet to 1 inch = 500 feet
2. Vehicle - a vehicle to carry team and equipment
3. Measuring Device - a 100-foot tape or measuring wheel and a 2 x 4 stud
4. Clip board, pencils, storage folders, stapler, markers and marking crayons, chalk and spray paint - supplies for each team member
5. Copies of the blank survey forms in Appendix A

STEP 2. DIVIDE EACH STREET INTO SECTIONS

Condition data will be tabulated for sections of each street that are reasonably consistent throughout their lengths. In most cases, the entire street can be considered as one section. The following are examples of section boundary points that may be used:

* intersections

* limits of past or present construction projects

* limits of seal or overlay projects

* changes in roadway geometrics such as:

  from two to four-lane

  from divided to undivided

  from roadway curb and gutter to shoulders only

* significant changes in visual appearance of surface or traffic characteristics

STEP 3. COMPLETE DATA SUMMARY FORM (FIGURE 1). NOTE: ALL FORMS ARE CONTAINED IN APPENDIX A.

Figure 1 shows the Data Summary Form that will be completed for each street section to be inventoried.

Street location is defined by the street name and the names of intersecting streets forming the boundaries for the particular street section. Each section should also be assigned a section number to keep the inventory forms in order. Section lengths can be determined from the base map.

Functional Data pertaining to surface width, number of lanes, median width, parking and sidewalks can be measured and recorded during this analysis. Average daily traffic counts may be available from the Montana Department of Highways or from local records. The type of drainage may be available from city records or can be determined in the field.

Structural Data should be available from the city's maintenance records. This information includes the date when the facility was constructed and the dates of each type of maintenance that has been done on the section.

Comments should include any other information pertinent to this section of street such as; "street section is an asphalt overlay over original concrete; or street widened 4 feet each side in 1980."

STEP 4. STUDY AND BECOME FAMILIAR WITH TYPES OF STREET INDICATORS DISTRESS (PROBLEMS)

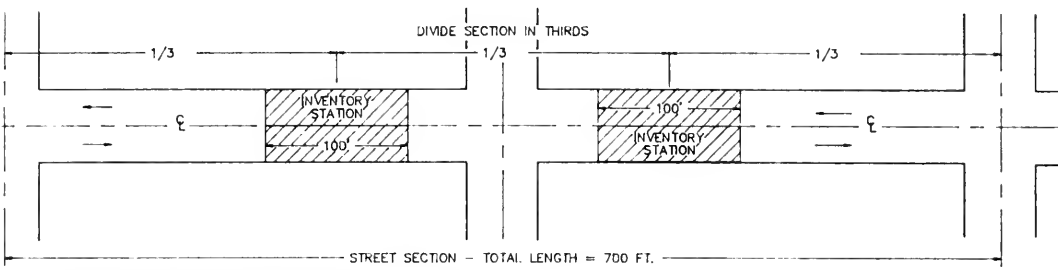
In addition to the Data Summary Form (Figure 1-1), the Inventory Data Form (Figure 2) is used when examining streets with flexible pavements (asphalt or similar types of streets). Concrete pavements are not included since very few streets of this type are currently in existence in small towns.

The Inventory Data Form (Figure 2) is used to record the surface condition of the section. Eight types of flexible pavement distress and seven types of unsurfaced street distress are observed and recorded during the condition inventory. These distress types are described and shown graphically on the following pages. The survey team should jointly study these distress descriptions and observe examples in the field so each member is able to make an identification consistent with that of other team members.

Point scores are assigned to each street to finally arrive at a Street Condition Index which can be used to rate the condition of paved and unpaved streets for the entire street system.

STEP 5. SELECT INVENTORY STATIONS

The condition survey will be made by inspecting two 100-foot lengths of street on each street section identified in Step 2. The following diagram shows the method of locating inventory stations.



THE STREET SECTION CAN BE ANY LENGTH. BOUNDARIES ARE LOCATED WHERE THERE IS A CHANGE IN WIDTH OR OTHER CHARACTERISTIC OF THE STREET – USUALLY, THE ENTIRE STREET CAN BE CONSIDERED A SECTION.

SCALE 1" = 100'±

The condition at the inventory station location should be typical of the rest of the street. If the condition at the inventory stations as shown on the diagram are not typical of the rest of the street, a typical location should be selected based on the judgment of the surveyor. Two inventory stations are selected so an average condition can be determined by combining the condition ratings. After selecting inventory stations, the condition survey may be started.

STEP 6. CONDUCT CONDITION SURVEY - FLEXIBLE PAVEMENT (ASPHALT STREETS)

Each type of distress is measured within the 100-foot inventory station and the severity and extent rating is checked on the Inventory Data Form. If a distress is not present, a zero is entered in the point scope for that distress. Figures 2A and 2B are examples of completed Inventory Data Forms.

Drainage has not been included in the condition analysis for paved streets. (It is included for unsurfaced streets). Poor drainage is one of the most frequent causes of the deterioration of streets, however, and it should be addressed as an overall system. It is beyond the scope of this publication to include the overall drainage system as a separate facility. Communities with obvious drainage problems should contact an engineer with drainage facility experience and should consider the development of a drainage system masterplan.

The condition survey of paved streets should be conducted annually. After the initial condition survey, some streets can be eliminated from the annual survey if they have been substantially improved during the year.

As you rate each distress refer to the examples shown in Figures 2A and 2B.

CONDITION SURVEY FOR SURFACED STREETS USING 8 DISTRESS TYPES

1. "RUTTING"

a. Description

For the purposes of this survey, a "rut" is a longitudinal surface depression (at least 20 ft. long) in a wheel path. "Wheel paths" are the two worn areas in each travel lane where most drivers position their vehicle. Heavy traffic volumes and heavy loads cause rutting in these areas. Rutting is usually caused by consolidation or lateral movement of roadbed material under heavy wheel loads.

b. Severity

The severity rating for rutting is measured by the depth of rutting. The depth of ruts can be measured by laying a yard stick or 2 x 4 over the rut and measuring to the bottom of the rut. The severity is rated as follows:

* Slight - (depth of ruts) 1/4" to 1/2"
* Moderate - (depth of ruts) 1/2" to 3/4"
* Severe - (depth of ruts) 3/4" +c) Extent

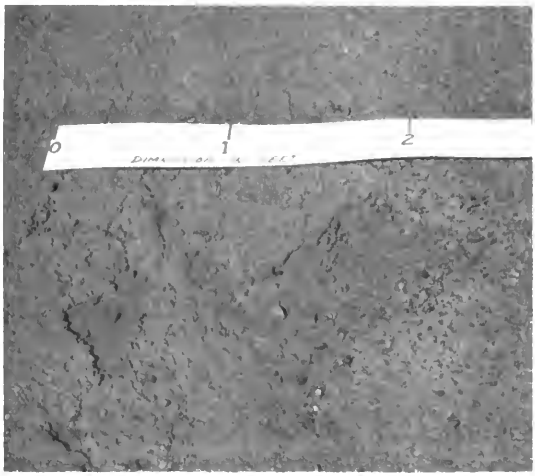
c. Extent

The extent of rutting is rated by the percentage of the wheel paths that are rutted. A single rutted wheel path on a two-lane street for the full length of the 100-foot inventory station constitutes a 25 percent rating. Four rutted wheel paths, two in each travel lane for 50' of the 100' station would be a 50 percent extent rating.

2. "RAVELING AND WEATHERING"

a. Description

"Raveling" or "weathering" is the wearing away of the pavement surface, resulting in a roughened surface texture due to dislodging of aggregate and loss of bitumen (asphalt binder or tar-like substance).



"Raveling" is the wearing away of the surface, usually as a result of traffic action. Weathering is the gradual disintegration of the surface, usually due to the drying out or loss of asphalt binder.

Ravel due to leaching out of the asphalt binder by oil and gas drippings is called "drip track ravel." Drip track ravel usually occurs at intersections, between wheel tracks. (make note under "remarks" on the inventory sheet).

Abraded surfaces (such as occur in snowfall areas where tire chains are used) should be rated as ravel and weathering. When the damage appears to be caused by tire chains or studs, it should be noted in "remarks" on the inventory sheet.

b. Severity

The relative degree of raveling and weathering is rated as follows:

* Slight - Fine aggregate and/or asphalt binder has worn away and the surface texture is slightly rough and pitted and some course rock is showing.

* Moderate - Some course aggregate and asphalt binder has worn away and the surface texture is moderately rough and pitted.

* Severe - Course aggregate and asphalt binder has worn away and the surface texture is severely rough and pitted.

Open graded surfaces, chip seals, and other surface treatments having an inherently coarse texture do not readily lend themselves to a "coarse" or "fine" ravel rating. An apparent ravel problem with these types of surfacing would be more appropriately described in the "Comments" section of the Data Summary Form (Figure I, Appendix A).

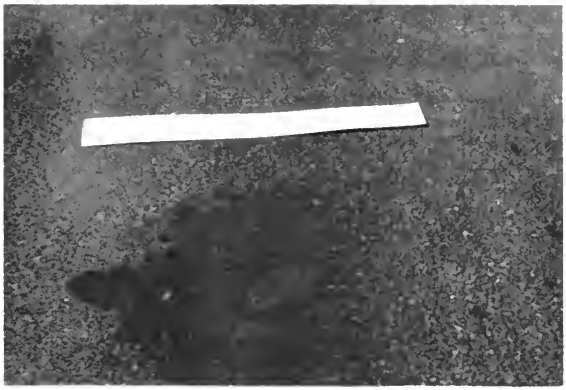
c. Extent

The extent of raveling and weathering is measured by the percentage of the length of the 100-foot inventory station raveled or weathered. For example, if the total length of raveled or weathered surface in the 100-foot length of inventory station is 25 feet, the extent is 25 percent.

3. "FLUSHING"

a. Description

"Flushing" occurs when asphalt comes to the surface of the roadway and partially or completely covers the aggregate making up the wearing surface of the roadway. Flushing is caused by too much oil in the mix.



b. Severity

Severity of flushing is rated by the amount of asphalt coming to the surface. The relative degree of flushing is rated as follows:

* Slight - Asphalt is barely noticeable in its coverage of the aggregate
* Moderate - Asphalt is covering large areas of the aggregate
* Severe - Asphalt is totally covering the aggregate

c. Extent

The extent of flushing is determined by measuring the length of the areas where flushing has occurred along the 100-foot inventory station and expressing it as a percentage of the total length.

4. "WASHBOARDING"

a. Description

"Washboarding" is a series of closely spaced ripples at fairly regular intervals perpendicular to the direction of travel. This type of distress is usually located in areas of acceleration or deceleration (e.g. near stop signs or in intersections) or in areas where the road is soft or potholed.

b. Severity

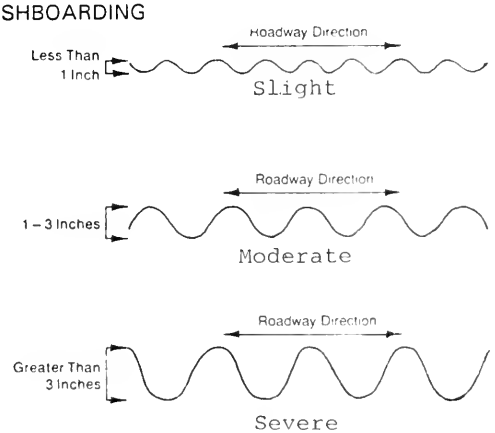
Severity is rated according to the effect the ripples have on the ride quality of the road. The relative degree of washboarding is rated as follows:

* Slight - Ripples are visible
* Moderate - Ripples create a bumpy ride, but do not require the vehicle to reduce its speed
* Severe - Ripples are prevalent enough to require the vehicle to reduce its speed

c. Extent

The extent of washboarding is determined by measuring the length of the rippled areas along the 100-foot inventory station and expressing it as a percentage of the total length (e.g. 50' washboarded over 100' inventory section is 50% extent).

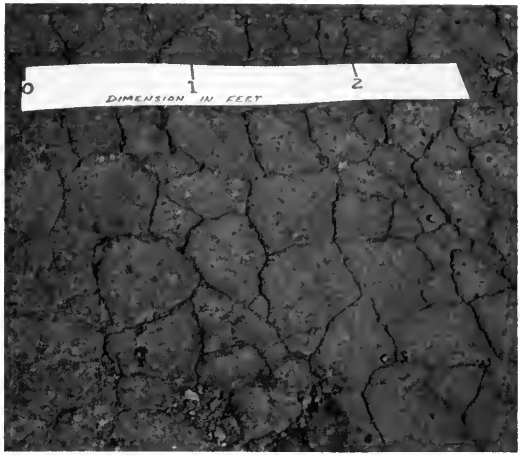
WASHBOARDING



5. "ALLIGATOR CRACKING"

a. Description

"Alligator cracking" occurs as interconnected or interlaced fatigue cracks form a series of small polygons. Alligator cracks are always associated with excessive loads.



Initially, a single longitudinal crack or a series of parallel cracks appear in a wheel path. Upon further loading, the cracks interconnect, forming the typical pattern resembling an alligator's skin or chicken wire. Alligator cracking does not usually occur over an entire area. Alligator cracks often indicate base failure (which will require reconstruction of the street's base at that location).

b. Severity

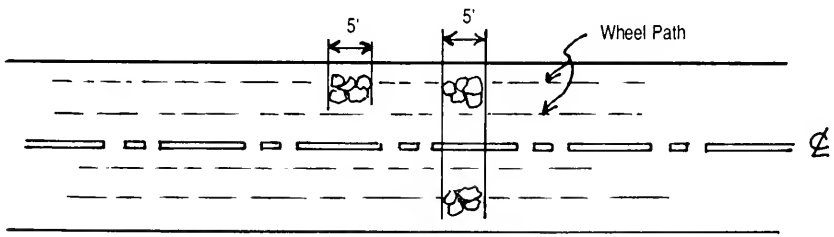
Severity is rated according to the extent to which the alligator cracking has developed. The relative degree of alligator cracking is rated as follows:

* Slight - The initial appearance of fatigue cracks in a wheel path
* Moderate - Interconnected fatigue cracks in a wheel path
* Severe - Fatigue cracks outside the wheel paths

c. Extent

The extent of alligator cracking is determined by measuring the length of the distressed areas along the 100-foot inventory station and expressing it as a percentage of the total length. The following sketch shows an inventory section with 10 lineal ft. of alligator cracking or an extent of 10 percent.

ALLIGATOR CRACKING



6. "TRANSVERSE CRACKING"

a. Description

"Transverse cracking" appears as cracks at approximately right angles to the street's centerline.

Transverse cracks are generally due to shrinkage of the surface course or old cracks resurfacing in a new overlay. They are not usually caused by heavy loads.

b. Severity

Severity is rated by the width of the crack. The relative degree of transverse cracking is rated as follows:

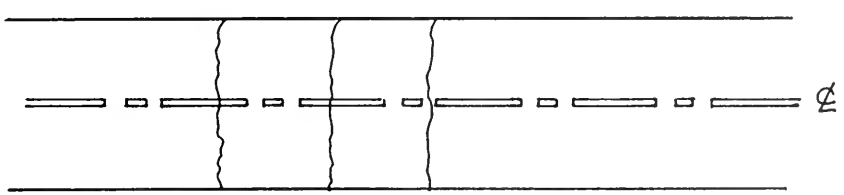
* Slight - Cracks are barely visible, less than 1/8" in width (hairline). Sealed cracks are rated as hairline.
* Moderate - Cracks are from 1/8" to 1/4" in width, but the sides of the crack are not fully separated.
* Severe - Cracks are 1/4" or more in width, and the sides of the crack are fully separated.

c. Extent

The extent of transverse cracking is determined by the number of cracks per 100-foot inventory station. This is then converted into a percentage range rating. The extent is rated as follows:

* 1 to 3 cracks per 100 ft.: 1 - 15%
* 4 to 7 cracks per 100 ft.: 16 - 30%
* 8 or more cracks per 100 ft.: +31%

TRANSVERSE CRACKING



7. "LONGITUDINAL CRACKING"

a. Description

"Longitudinal cracking" appears as cracks approximately parallel to the pavement centerline.

Longitudinal cracks are primarily caused by opening of paving joints, shrinkage of the surface course, reflection cracking, and roadbed settlement.

Load-associated longitudinal cracks in the wheel path are rated as slight alligator cracking (see Alligator Cracking).

b. Severity

Severity is rated by the width of the crack. The relative degree of longitudinal cracking is rated as follows:

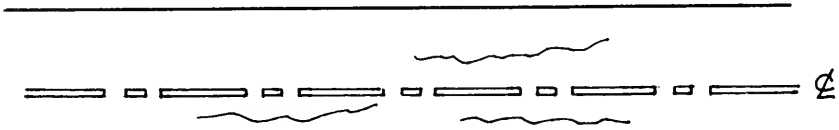
* Slight - Cracks are barely visible, less than 1/8" in width (hairline). Sealed cracks are rated as hairline.
* Moderate - Cracks are from 1/8" to 1/4" in width, but the sides of the crack are not fully separated.
* Severe - Cracks are 1/4" or more in width and sides of the crack are fully separated.

c. Extent

The extent of longitudinal cracking is determined by measuring the total lineal feet of cracks per 100-foot inventory station and then converting it to a percentage range rating. The extent is rated as follows:

* 100 - 300 lineal ft. of crack/100-ft. station: 1 - 15%
* 301 - 600 lineal ft. of crack/100-ft. station: 16 - 30%
* 601+ lineal ft. of crack/100-ft. station: +31%

LONGITUDINAL CRACKING



8. "PATCHING"

a. Description

"Patches" are temporary or permanent corrections to damaged pavement. A patch is considered a problem area, no matter how well it is performing.

Materials used to patch flexible pavements may vary, but are usually of asphaltic composition.

b. Severity

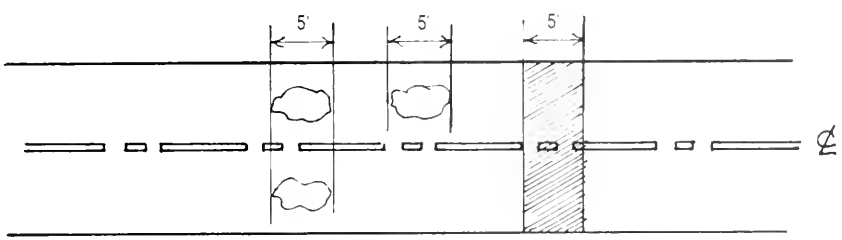
Severity is rated subjectively according to how surface conditions affect ride. The relative severity of patching is rated as follows:

* Slight - Patch is in good condition, level with pavement, and does not affect ride.
* Moderate - Patch is somewhat deteriorated but does not require a vehicle to reduce its speed.
* Severe - Patch is in poor condition or has resulted in a pothole requiring a vehicle to reduce speed.

c. Extent

The extent of patching is determined by measuring the length of the areas patched along the 100-foot inventory station and expressing it as a percentage of the total length. The following sketch shows an inventory section with patching extent of 15 percent.

PATCHING



STEP 7. CONDUCT UNSURFACED STREETS SURVEY

The inventory of unsurfaced streets can be carried out at the same time the paved streets are inventoried. The Inventory Data Form and scoring key are similar to that for paved streets, however different distresses are present in unsurfaced streets.

The unsurfaced streets inventory should be conducted annually. Streets that are scheduled for paving can be eliminated from the inventory.

Seven distresses are measured and used to rate the condition of unsurfaced streets.

These are:

1. Improper Cross Section
2. Inadequate Roadside Drainage
3. Washboarding
4. Dust
5. Potholes
6. Ruts
7. Loose aggregate gravel

The sections that follow describe how to identify and measure the seven distress types for unsurfaced streets. At the completion of the inventory, the inventory team and the governing body should identify any unpaved streets that they wish to pave. The decision to pave is usually based on: amount and type of traffic using the street, desires of property owners, dust control and availability of funds. See form for unpaved roads in Appendix A, Figure 4.

1. CROSS SECTION

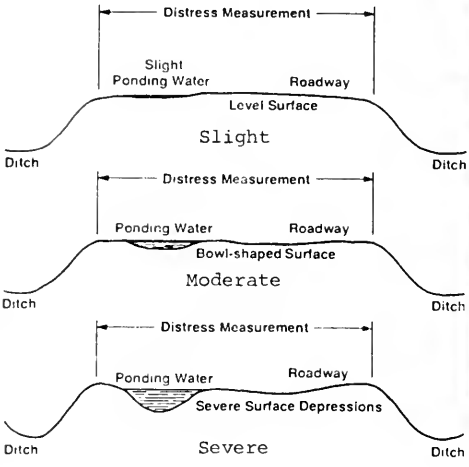
a. Description: An unsurfaced road should have a "crown" with enough slope from the centerline to the shoulder to drain all water from the road's surface. No crown is used on curves, because they are usually banked. The road cross section is improper when the road surface is not shaped or maintained to carry water to the side of the road. The cross section can be more easily seen by laying a 2" x 4" across the centerline of the road.

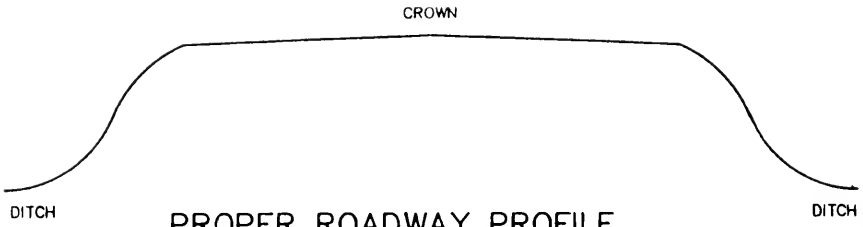
b. Severity:

Slight:	Small amounts of ponding water or evidence of ponding water on the road surface; or
	The road surface is completely flat (no cross-slope)
Moderate:	Moderate amounts of ponding water or evidence of ponding water on the road surface; or
	The road surface is bowl shaped
Severe:	Large amounts of ponding water or evidence of ponding water on the road surface; or
	The road surface contains severe depressions.

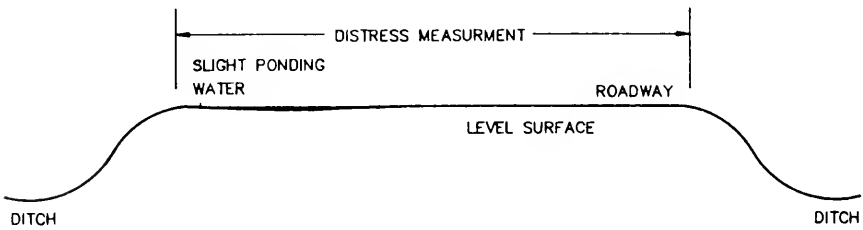
c. Extent:Cross section distress is measured in linear feet per inventory section (along the centerline or parallel to the centerline). The cross section runs from the outside shoulder break on one side of the road to the outside shoulder break on the other side. The average severity should be estimated. The extent of 30 feet of improper cross section in the 100-foot inventory section would be 30 percent.

CROSS SECTION DISTRESS

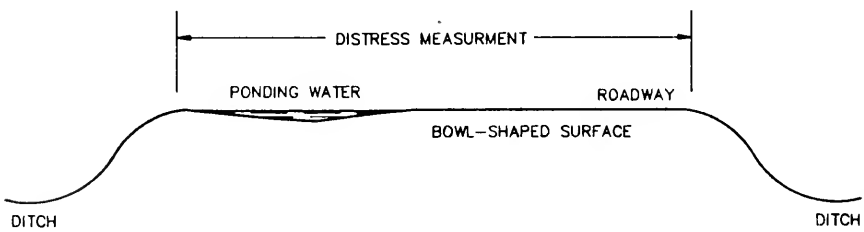




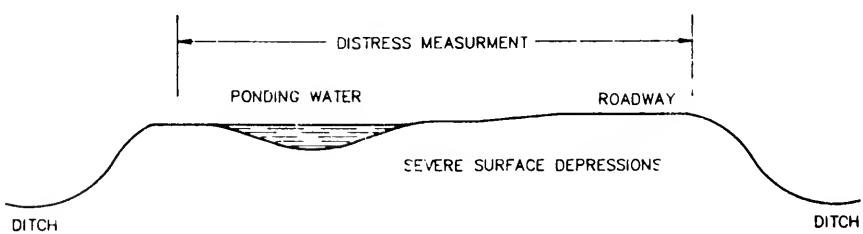
PROPER ROADWAY PROFILE



SLIGHT



MODERATE



SEVERE

2. ROADSIDE DRAINAGE

a. Description: Poor drainage is generally a primary factor contributing to the deterioration of paved or unsurfaced roadways. The solution to poor drainage involves the development of an overall drainage system, which is beyond the scope of this document. In urban areas, unsurfaced streets are usually short in length and seldom have well defined drainage ditches. In most cases, water is channeled into shallow swales or abutting property.

b. Severity Levels:

Slight: Small amounts of ponding water or evidence of ponding water along the edges of the roadway with some debris or overgrowth along the roadway.

Moderate: Moderate amounts of ponding water or evidence of ponding water along the edges of the roadway with debris or overgrowth along the roadway or erosion of the edge of the roadway.

Severe: Large amounts of ponding water or evidence of ponding water along the edges of the roadway with debris or overgrowth along the roadway or erosion of the edge of the roadway into the roadway surface.

c. Extent: Drainage problems are measured in lineal feet of distress. The maximum length is 2 times the length of the inventory section (200 ft.). To compute extent, divide the no. of lineal feet of distress by 200 feet.

Example: If the section has 50' of distress, 50 - 200 = 25% extent.

NOTE: Drainage score not shown in example Figure 2A for paved roads. See form used for unpaved roads (Figure 4 in Appendix A).

ROADSIDE DRAINAGE DISTRESS

3. WASHBOARDING

a. Description: Washboarding consists of closely spaced ridges and valleys (ripples) at fairly regular intervals. The ridges are at a right angle to the traffic direction. This type of distress is usually caused by traffic and loose aggregate. These ridges usually form on hills, on curves, in areas of acceleration or deceleration, or in areas where the road is soft or potholed.

b. Severity:

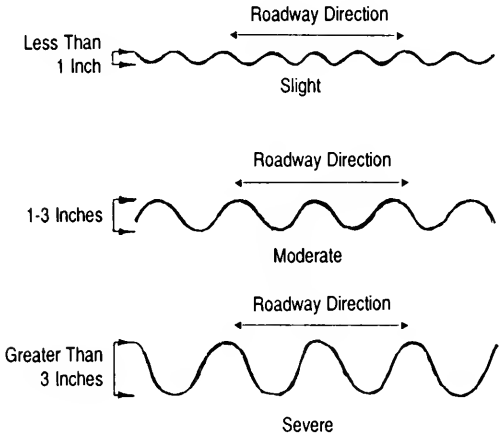
Slight: Washboarding is less than 1 inch deep.

Moderate: Washboarding is between 1 and 3 inches deep.

Severe: Washboarding is deeper than 3 inches.

c. Extent: The extent of washboarding is determined by measuring the length of the rippled areas along the 100-foot inventory section and expressing it as a percentage of the total length (e.g. 50' washboarded over 100' section is 50% extent).

WASHBOARDING



4. DUST

a. Description: The wear and tear of traffic on unsurfaced roads will eventually loosen the larger particles from the soil binder. As traffic passes, dust clouds create a danger to trailing or passing vehicles and cause significant environmental problems.

b. Severity:

Slight: Normal traffic produces a thin dust that does not visibility.

Moderate: Normal traffic produces a moderately thick cloud that partially obstructs visibility and causes traffic to slow down.

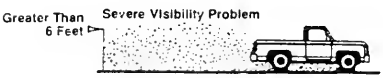
Severe: Normal traffic produces a very thick cloud that severely obstructs visibility and causes traffic to slow down significantly or stop.

c. Extent: Drive a vehicle at 25 mph and watch the dust cloud. Dust is measured as slight, moderate, or severe for the sample unit (as illustrated by the diagram below). Dust measurements must be taken on a dry road surface during a relatively dry period.

DUST

Slight

Moderate



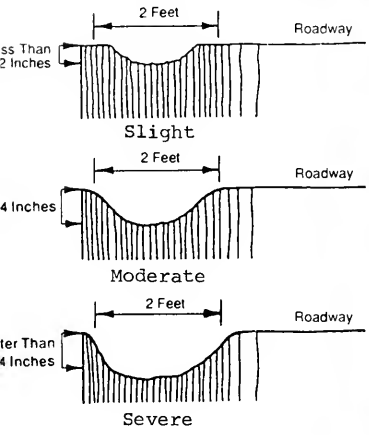
Severe

5. POTHOLES

a. Description: Potholes are bowl-shaped depressions in the road surface. They are usually less than 3 feet in diameter. Potholes are produced when traffic wears away small pieces of the road surface. They grow faster when water collects inside the hole. The road then continues to disintegrate because of loosening surface material or weak spots in the underlying soils and vehicle impacts.

b. Severity: The levels of severity for potholes are based on both the diameter and the depth of the pothole according to the following diagram:

POTHOLES



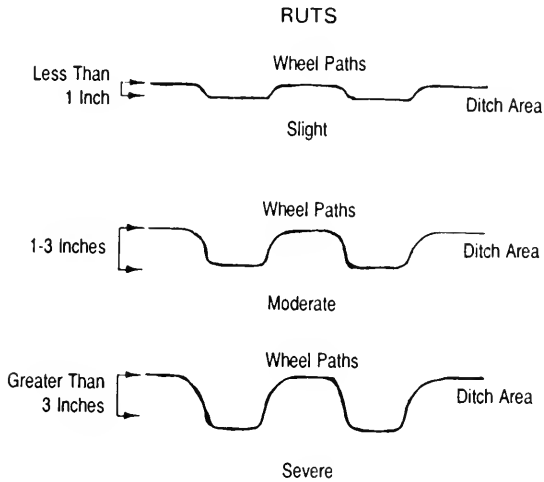
c. Extent: The extent of pothole distress is measured as a percent of the length of the inventory station with potholes. For example, if the total length of potholed roadway along the 100 ft. inventory section is 20 feet, the extent is 20 percent.

6. RUTS

a. Description: A "rut" is a surface depression in the wheel path that is parallel to the road centerline. Due to the low traffic volumes on must unsurfaced roads and streets, there are generally two apparent wheel paths, rather than 4 that are apparent on 2-way, 2-lane paved streets. Ruts are caused by a permanent deformation in any of the road layers or subgrade. They result from repeated vehicle passes, especially when the road is soft. Significant rutting can destroy a road.

b. Severity:

Slight: Ruts are less than 1 inch deep.
Moderate: Ruts are between 1 and 3 inches deep.
Severe: Ruts are deeper than 3 inches.



c. Extent: The extent of rutting is rated by the percentage of the two wheel paths that are rutted. A single wheel path rutted for the full length of the 100 foot inventory section constitutes a 50 percent rating. If both wheel paths are rutted for the full length of the 100 foot inventory section, this is given a 100 percent rating.

7. LOOSE AGGREGATE (Gravel)

a. Description: The wear and tear of traffic on unsurfaced roads will eventually loosen the larger aggregate particles from the soil binder. This leads to loose aggregate particles on the road surface or shoulder. Traffic moves loose aggregate particles away from the normal road wheel path and forms berms in the center or along the shoulder (the less-traveled areas). Berms are a problem because they cause vehicles to swerve or "fishtail" as if on ice. They also prevent proper drainage from the roads surface.

b. Severity:

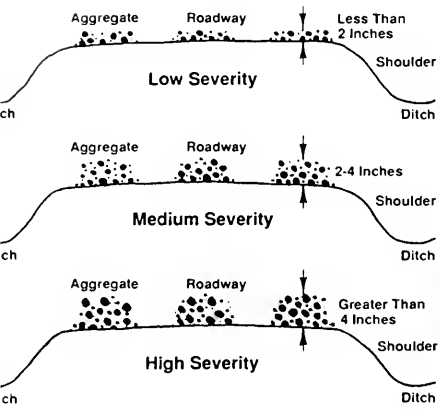
Slight: Loose aggregate on the road surface, or a berm of aggregate (less than 2 inches deep) on the shoulder or less-traveled area.

Moderate: Moderate aggregate berm (between 2 and 4 inches deep) on the shoulder or less traveled area. A large amount of fine soil particles is usually found on the roadway surface.

Severe: Large aggregate berm (greater than 4 inches deep) on the shoulder or less-traveled areas.

c. Extent: Loose aggregate usually forms in 3 berms as shown in the sketch. The extent is rated as the percentage of 3 berms of the total length of the inventory section. For example, 3 berms of loose aggregate for 25 feet of the 100 foot inventory section would be rated as a 25 percent extent. One berm extending the entire length of the section would be 33 percent, 2 berms, 50 percent and 3 berms, 100 percent.

LOOSE AGGREGATE



STEP 8. RATE RIDING QUALITY OF STREET

After the street surface inventory is completed, the street section is driven by the survey team in an "average" passenger car and the riding quality is ranked according to the following criteria:

Rank	Riding	Criteria

1. There are no problems in driving the speed limit
2. There is some roughness and bumpy ride when driving the speed limit
3. It is difficult to handle the vehicle when driving the speed limit. In some situations the driver is forced to drive slower than the speed limit
4. It is impossible to drive the speed limit

The appropriate rank number for the street section is entered on the Data Summary Form.

STEP 9. HOW TO SCORE THE DISTRESS TYPES

When the condition survey is completed, the following information will be available for each street section:

* Data Summary Form (Fig. 1, Appendix A) - completed except for total distress points and the Street Condition Index
* Inventory Data Forms (Fig. 2 or 4, Appendix A) - two completed forms, one for each inventory station on each street section

The following is an example of the steps required to calculate the total distress points and street condition index for a typical section of paved street. The figures referred to are shown on pages A-1 to A-6.

Step 9A. Figures 2A and 2B are examples of Inventory Data Forms which have been completed for each of the two inventory stations on the street section. The score for each of the 8 distress types is computed by using Figure 3, the Scoring Key. For example, inventory station 1-1 (Figure 2A) has an extent of 16-30 percent for rutting and a "moderate" severity rating for rutting. Next, compare this information with Figure 3 which shows that "16-30 percent/moderate" rutting is awarded 4 points. This number (4) is then entered as the score under "rutting" in Figure 2A. This procedure is then used to determine the point score for each of the 7 remaining distress types (i.e. "raveling - patching").

Step 9B. Total the distress points in the left hand column of Figure 2A (i.e. "rutting - patching, etc.") and enter the total distress points in the space on the right hand top of Figure 2A. The total distress points for inventory section 1-1 are 38. This same procedure is used to complete Figure 2B for inventory section 1-2. Thus, section 1-2 has a distress point total of 41.

Step 9C. The total distress points from each Inventory Data Form (Figures 2A and 2B) are entered on Figure 1. The total distress points for each inventory station are added and divided by two to arrive at the Average Total Distress Points for the street section. (38 + 41) - 2 = 39.5

Step 9D. The Street Condition Index (SCI) is determined by subtracting the Average Total

Distress points from 100. 100 - 39.5 = 60.5. (The lower the SCI number, the worse the condition of the street. The higher the number, the better the street.)

Step 9E. The work order category (type of repair recommended) is determined by the SCI point ranges shown on the bottom of Figure 1. For example, a SCI of 60.5 falls into the 80 - 66 point range which calls for an overlay on paved streets. (If the street was not paved, a SCI of 60.5 would call for adding gravel to the street.)

The steps for computing the SCI and work order category for unsurfaced streets are the same as the foregoing procedure (which used a paved street as an example). The unsurfaced street forms are Figures 4 & 5 in Appendix A.

Continue on to Step 10.

EXAMPLE
PAVED STREET

FIGURE I

DATA SUMMARY FORM

DATE 7-5-88

LOCATION

Average Total Distress Points (38+41)-2 = 39.5
Riding Quality 1.5
SCI *=100-Total Dist. Pts. 60.5

Street Name Elm
From Poplar To Oak
Section No. 1 Length (to tenths of mile) 3250'

FUNCTIONAL ADEQUACY

Surface Type ____ Paved x Unsurfaced ____
Surface Width 24 No. of lanes 2 Median Width None
Parking on Street Yes ____ No x Sidewalks Yes x No ____
at curb x
detached

Average daily traffic 1500
Drainage
Storm Sewer ____ V Gutter ____
Unpaved Side Ditch ____ Paved Side Ditch ____
Curb and Gutter x

STRUCTURAL ADEQUACY

Date of Construction 1975
Maintenance History:
Surface Overlay 1982
Seal Coat 1985
Crack & Joint Maintenance 1985
Estimated Cost Overlay- Seal-
Comments Water line to be installed on this section - Sept. 1988

Work Order Category Overlay

*SCI - Street Condition Index

100 - 81	1.	No Immediate Maintenance
80 - 66	2.	Routine Maintenance
65 - 46	3.	Overlay or Gravel
45 - 0	4.	Reconstruction

FIGURE 2A
INVENTORY DATA FORM
(Flexible Pavement)
EXAMPLE

Total Distress Points 38

Street Name Elm INVENTORY STATION 1-1

From Poplar To Oak

RIDING QUALITY (Check one) 1 [X] 2 [ ] 3 [ ] 4 [ ]

Types of Distress	Degree of Distress	Percentage of Area			
		1-15%	16-30%	31%+	
RUTTING 4 Score	Slight				
	Moderate		x		
	Severe				
RAVELING 8 Score	Slight				
	Moderate		x		
	Severe				
FLUSHING 6 Score	Slight				
	Moderate	x			
	Severe				
CORRUGATIONS 5 Score	Slight		x		
	Moderate				
	Severe				
ALLIGATOR CRACKING 6 Score	Slight				
	Moderate	x			
	Severe				
TRANSVERSE CRACKING 6 Score	Slight				Check One: Sealed ___ Partially Sealed x Not Sealed ___
	Moderate		x		
	Severe				
LONGITUDINAL CRACKING 3 Score	Slight	x			Check One: Sealed ___ Partially Sealed x Not Sealed ___
	Moderate				
	Severe				
PATCHING 0 Score	Slight	x			
	Moderate				
	Severe				

FIGURE 2 B
(Flexible Pavement)
EXAMPLE

Total Distress Points 41

Street Name Elm Section No. 1 - 2

From Poplar To Oak

RIDING QUALITY (Check one) 1 ☐ 2 ☒ 3 ☐ 4 ☐

Types of Distress	Degree of Distress	Percentage of Area			
		1-15%	16-30%	31%+	
RUTTING 0 Score	Slight	x			
	Moderate				
	Severe				
RAVELING 8 Score	Slight				
	Moderate		x		
	Severe				
FLUSHING 3 Score	Slight	x			
	Moderate				
	Severe				
WASHBOARDING 8 Score	Slight				
	Moderate		x		
	Severe				
ALLIGATOR CRACKING 9 Score	Slight				
	Moderate				
	Severe	x			
TRANSVERSE CRACKING 4 Score	Slight		x		Check One: Sealed ___ Partially Sealed x Not Sealed ___
	Moderate				
	Severe				
LONGITUDINAL CRACKING 6 Score	Slight				Check One: Sealed ___ Partially Sealed ___ Not Sealed x
	Moderate	x			
	Severe				
PATCHING 3 Score	Slight				
	Moderate	x			
	Severe				

FIGURE 3
SCORING KEY
(Flexible Pavement)

Street Name _____ Section No. _____

From _____ To _____

Types of Distress	Degree of Distress	Percentage of Area		
		1-15%	16-30%	31%+
RUTTING	Slight	0	1	3
	Moderate	3	4	6
	Severe	6	8	9
RAVELING	Slight	3	5	6
	Moderate	6	8	9
	Severe	9	11	13
FLUSHING	Slight	3	5	6
	Moderate	6	8	9
	Severe	9	11	13
WASHBOARDING	Slight	3	5	6
	Moderate	6	8	9
	Severe	9	11	13
ALLIGATOR CRACKING	Slight	3	6	9
	Moderate	6	9	12
	Severe	9	12	16

		S	PS	NS	S	PS	NS	S	PS	NS
TRANSVERSE CRACKING	Slight	1	3	5	2	4	6	2	4	8
	Moderate	3	5	6	4	6	9	4	8	9
	Severe	5	6	9	6	9	12	8	9	12
		S	PS	NS	S	PS	NS	S	PS	NS
LONGITUDINAL CRACKING	Slight	1	3	5	2	4	6	2	4	8
	Moderate	3	5	6	4	6	9	4	8	9
	Severe	5	6	9	6	9	12	8	9	12

S = Sealed
PS = Partially Sealed
NS = Not Sealed

PATCHING	Slight	0	1	3
	Moderate	3	4	6
	Severe	4	9	12

STEP 10. ANALYZE SURVEY RESULTS

A Preliminary Street Improvement Priorities Form (Appendix A, Figure 6) is prepared which shows for each section: relative condition, Street Condition Index (SCI) numbers, work order category, cost estimates and other information. Cost estimates for routine maintenance, overlay or gravel and reconstruction should be computed from past projects, town maintenance records and estimates from local contractors.

Figure 6 shows an example of a completed Preliminary Street Improvement Form for the Town of East Helena. The costs are based on local estimates.

The SCI numbers for all of the town's streets are listed in order from low to high. The lower the SCI, the worse the street condition. This results in a preliminary street improvement priority list.

* For cities/towns under 5,000 Population, go to step 13 (skip steps 11 & 12)
* For cities over 5,000 Population, complete steps 11 - 13

STEP 11. FUNCTIONAL CLASSIFICATION (CITIES OVER 5,000 POP.)

Urban areas with a population of 5,000 or more are eligible for Federal Aid Urban Funds and are required to consider other factors in setting street improvement priorities. Steps 11 and 12 apply to cities with 5,000+ population.

For cities or towns with a 1980 census urban area population of 5,000 persons or more, a map showing the functional classification of the major street system has been prepared by the Montana Department of Highways. This map should be on file at City Hall or a copy can be obtained from MDOH. Obtain a copy of this map.

The functional classification separates streets into 3 major categories based on the specific function of the street. These categories are arterials, collectors and local streets. The following is a brief description of each category.

Arterial Streets:

* serve major activity centers
* have the highest traffic volumes
* carry the longest trips in the system
* carry a high proportion of the total urban area travel on a minimum of mileage
* service to abutting land is subordinate to providing travel service to major traffic movements

DATE: MAY 1988

PRELIMINARY STREET IMPROVEMENT PRIORITIES - EAST HELENA

STREET	FROM	TO	SURFACE TYPE	(1) SCI	LENGTH FT.	WIDTH FT.	AREA-SQ YD(3x4)-9	WORK ORDER	0.30/YARD SLURRY	COST 4.75/YD OVERLAY OR GRAVEL	7.30/YD RECONST.	EST. DATE(2) TO CONST.	SOURCE (3) OF $
LARK	THURMAN	LANE	PAVED	60	2255	32	8018	SLU. OR OVER.	2405	38085			
WASHINGTON	PORTER	LEWIS	PAVED	66	2536	32	9017	MAINT.	2705				
CLINTON	HELENA	KALISPELL	PAVED	69	1915	32	6809	MAINT.	2043				
CLARK	LANE	CITY LIM.	UNSURFACED	71	1175	24	3133	MAINT.	940				
DUDLEY	MONTANA	KALISPELL	UNSURFACED	72	1565	32	5564	MAINT.	1669				
KING	HELENA	KALISPELL	UNSURFACED	72	1915	32	6809	MAINT.	2043				
PRICKLY PEAR	PORTER	LEWIS	UNSURFACED	74	2573	32	9148	MAINT.	2744				
GRAND	PORTER	LEWIS	UNSURFACED	78	2566	32	9124	MAINT.	2737				
LARK	LANE	CASEY	UNSURFACED	78	545	32	1938	MAINT.	581				
RIGGS	MONTANA	KALISPELL	UNSURFACED	79	1545	32	5493	MAINT.	1648				
GROSCHELL	HARRISON	KALISPELL	UNSURFACED	83	2875	32	10222	NO ACTION					
THURMAN	CLINTON	GROSCHELL	UNSURFACED	83	326	24	869	NO ACTION					
LEWIS	MONTANA	WASHINGTON	PAVED	86	1220	32	4338	NO ACTION					
KALISPELL	MAIN	LEWIS	UNSURFACED	89	2606	24	6949	NO ACTION					
LARK	MONTANA	CREEK	PAVED	90	275	32	978	NO ACTION					
RIGGS	4TH	MONTANA	PAVED	91	3890	32	13831	NO ACTION					
PACIFIC	CREEK	MONTANA	PAVED	94	1145	32	4071	NO ACTION					
MORTON	PACIFIC	GROSCHELL	PAVED	94	902	32	3207	NO ACTION					
MONTANA	CITY LIM.	LEWIS	PAVED	94	3718	32	13220	NO ACTION					
?	PACIFIC	GROSCHELL	PAVED	95	818	32	2908	NO ACTION					
GROSCHELL	4TH	MONTANA	PAVED	96	2187	32	7776	NO ACTION					
3RD	MAIN	GROSCHELL	PAVED	98	596	32	2119	NO ACTION					
1ST	MAIN	GROSCHELL	PAVED	98	595	32	2116	NO ACTION					
HARRISON	MAIN	GROSCHELL	PAVED	99	626	32	2226	NO ACTION					
PACIFIC	2ND	CREEK	PAVED	100	1665	32	5920	NO ACTION					
2ND	PACIFIC	GROSCHELL	PAVED	100	672	32	2389	NO ACTION					
?	PACIFIC	GROSCHELL	PAVED	100	1053	32	3744	NO ACTION					
HELENA	PACIFIC	KING	PAVED	100	1682	32	5980	NO ACTION					

(1) The lower the SCI number, the worse the condition of the street.
(2) See Chapter 5, Overview Matrix.
(3) See Chapter 6, Raising the Money.

FIGURE 6

Collector Streets:

* streets connecting the arterial system to the local system
* carry some through traffic, but primarily carry local traffic within residential, commercial, and industrial areas

Local Streets:

* includes all streets not classified as arterials or collectors
* primarily provide direct access to abutting land and access to collectors or arterials
* through traffic is discouraged

Design Standards

The streets making up each functional category should be designed to meet the specific function the street is to perform. For example, by designing an arterial street to a minimum of 44 ft. in width, the street can be used as a two-lane facility with two 12-foot travel lanes and two 10-foot parking lanes or, if traffic volumes increase, it can function as a four-lane street with four 11-foot travel lanes.

For communities that do not have adopted design standards, the following widths should be considered minimums:

Functional Classification	Minimum Width (ft.)
Local Street	18
Collector Street	24
Aterial Street	30

(These standards are from A Policy on Geometric Design of Highways and Streets, 1984, by the American Association of State Highway and Transportation Officials). For construction of streets in proposed subdivisions, refer to Montana Model Subdivision Regulations, 1982, by the Montana Department of Commerce, Local Government Assistance Division.

Community officials should review and adopt design standards that are compatible with the existing street system. If some of the community's streets are substandard, local officials should consider improving the streets to current design standards. Contact a traffic engineer or the MSU Rural Technical Assistance Program (994-6100) if you need help in determining the appropriate standards for the streets.

STEP 12. OPERATIONAL ANALYSIS (CITIES OVER 5,000 POP. ONLY)

The operation of the street system is evaluated by observing and recording traffic movement on the system. Appendix B contains the forms necessary to carry out this analysis.

The operational analysis consists of preliminary analysis of accidents and traffic volumes which may lead to a detailed analysis by qualified traffic engineer to determine if capital improvements to the system can be used to correct the deficiencies. Prior to conducting these surveys, a qualified traffic professional should be consulted.

A. Accidents

Clusters of accidents usually indicate a deficiency in the street system. Where one or two

accidents may be due to driver error or vehicle malfunction, a cluster of accidents indicate as a need for evaluating the traffic operations and roadway characteristics at a location.

A printout of accident data for each federal aid urban area (5,000 or more population) in the state is available upon request from the Montana Department of Justice, Highway Traffic Safety Division. The printout will identify locations where there are clusters of accidents. Figure 1 Appendix B, the Accident Summary Form, can be used to summarize the general characteristics of the accidents at each location. Locations where a number of accidents show similar characteristics may require improvements that should be included in the street system CIP. Before major improvements are programmed based on accident experience, a detailed analysis of each accident report should be made by an experienced traffic engineer. Once locations where similar accidents have been identified by compilation of the Accident Summary sheet, a professional analysis should be carried out. Sources of this expertise are:

* Montana Department of Transportation (Federal Highway Aid System) phone: 444-6124

* Department of Justice, Traffic Safety Division (Off-System) phone: 444-3412

* Consulting Traffic Engineer

B. Traffic Counts

Traffic operational problems such as congestion and delay may be the result of inadequate street capacity. A preliminary analysis of a street's capacity to carry existing traffic can be made by: a) taking peak hour turning movement counts; or b) using the planning method for estimating the level at which the location is operating given in the Highway Capacity Manual (Special Report 209, Transportation Research Board, National Research Council, 1985). Urban areas with less than 5,000 population generally do not have traffic volumes on the local street system that would exceed the capacity of the intersections. Signalized intersections in these areas usually come under the jurisdiction of the Montana Department of Highways. However, if there are intersections experiencing congestion and long delays, this simplified analysis can be applied to determine if lack of capacity is the cause of congestion and to determine which movements at the intersection are near or over capacity. Refer to Appendix B, page B-5, for the planning analysis method excerpted from the Highway Capacity Manual.

The steps required to conduct this capacity analysis are as follows:

a. Select Locations to be Analyzed

Street capacity problems generally occur at intersections where there are a number of turning movements. The first step in evaluating the level of operation at critical locations is to identify locations where peak hour delays are occurring. This can be done by a staff person who is familiar with the operation of the street system or by selecting all signaled intersections for analysis. The approach used depends on the manpower available to carry out the turning movement counts.

b. Conduct Turning Movement Counts

Peak hour turning movements counts will be used for the analysis. Normally, the peak hour at an intersection is during the evening peak which occurs between 4:00 p.m. and 6:00 p.m. At most locations, it will be adequate to conduct the turning movement counts for this two-hour period. If there is reason to believe that the peak hour may occur during the morning or noon peak hour, counts should also be made from 7:00 a.m. to 9:00 a.m. and from 11:00 a.m. to 1:00 p.m. Figure 2 Appendix B is a Turning Movement Count form that can be used to tabulate the turning movement counts. Two persons can usually count an intersection. All vehicles entering the intersection are counted and tabulated in the proper space on Figure 3, Appendix B. One person counts the vehicles on the north and west

approaches of the intersection and the other person counts the south and east approaches. Counts are hand-tabulated by tally marks in groups of five.

The counts are made in 15-minute increments. These are separated by drawing a line under the tally marks for each 15-minute period. One sheet is usually sufficient for one hour or four 15-minute periods. Columns are divided so that vehicles can be identified as passenger vehicles (P) or trucks (T). Trucks are considered to be any vehicle with at least one axle having dual tires.

Total counts for each 15-minute interval for each turning movement are summarized on the Vehicle Volume Summary Form shown in Figure 3 Appendix B.

The morning and evening peak hour periods are determined by combining the highest four consecutive 15 minute periods. The peak hour volumes are then entered on Figure 4, Appendix B, the Planning Application Worksheet. The steps required to complete the worksheet are self explanatory.

If an intersection has critical peak hour volumes in the "near" or "over" capacity volume ranges shown on Figure 4, Appendix B, a detailed operational analysis of the intersection should be carried out by a qualified engineer.

Improvements that may be necessary to increase the capacity of the intersection may include:

* Operational adjustments to the signal
* Addition of separate turn signals
* Additional turning lanes
* Channelization
* Removal of parking
* Flare intersection
* Add acceleration and/or deceleration lanes

STEP 13. SETTING STREET IMPROVEMENT PRIORITIES (ALL CITIES/TOWNS)

At this point you may want to review the preliminary street improvement priority list (see step 10). Make changes and adjustments as necessary based on practical considerations. The Street Condition Index (SCI) ratings indicate the relative degree of distress and deterioration for each street segment. The SCI ratings do not include such concerns as:

* The relative importance of the street segment with regard to the overall system. Major streets in the system should generally take priority over residential streets serving only a few houses.
* The amount of traffic a street is carrying
* Water or sewer improvements that should be completed before the street is improved
* Street improvements needed to serve newly developing areas

Considering the above factors may change the priority ranking of the various street segments. For cities with over 5,000 population the street operational analysis may pinpoint some additional improvements needed to improve safety or traffic flow.

When the public works director or maintenance supervisor has completed the street improvement priority list, the information is ready to be presented to the Mayor and Council. Explain the data collection process and present the street improvement priority list for review and comments. The Mayor and Council may suggest changes in the priorities based on other facility needs and the availability of funds.

Chapters V and VI of this document set forth procedures for coordinating street, water and sewer improvements and for obtaining funds for these improvements.

The options available to pay for the street improvements must be studied by the lead financial researcher and financial decisions made by the governing body (see Chapter VI, Raising the Money).

CHAPTER THREE

WATER SYSTEM NEEDS ANALYSIS

OVERVIEW OF CHAPTER

The purpose of this chapter is to provide background information, inventory procedures, evaluation methods, and priority setting procedures for planning improvements to water treatment, pumping, storage, and piping systems. The method outlined is a model approach that has been tested and used in some Montana cities and towns. However, your engineer or public works director may recommend an alternative evaluation approach which is appropriate to the needs of your community.

IMPORTANCE OF ADEQUATE WATER SYSTEMS

The average citizen takes clean drinking water for granted. Some feel that water is a "free" commodity that should simply be available when needed. Few consider it a "manufactured" product, which is the case in many localities. Consider the following:

* Humans can survive only a few days without drinking water.

* Certain water-borne bacteria and viruses cause highly contagious diseases such as hepatitis and typhoid fever. These diseases can be fatal.

* Nitrate concentrations in drinking water causes the fatal newborn disease known as "blue baby" disease (methemoglobinemia).

* Heavy metal pollutants and some volatile organic compound pollutants may cause miscarriages, birth defects, mental retardation, and cancer.

* Adequate water systems are necessary for community growth and business development.

* Inadequate fire flow capacity affects fire insurance ratings and increases the cost of property owners insurance.

* Lack of planning and management often result in preventable user fee increases.

It is therefore essential that public water supplies be managed to protect public health and to encourage community development.

The Montana Department of Health and Montana Department of Commerce estimate that Montana's community water systems are in immediate need of $268 million in repairs and rehabilitation. The figure is a rough estimate and does not include rural water systems, unincorporated systems, or water districts. Taking into consideration these additional systems, the real need may exceed $268 million. The ever increasing competition for grant and low interest loan dollars, the decreasing availability of those funds, distressed economic conditions, and a lack of effective financial planning are contributing to a problem that has reached staggering proportions. Only through intensive financial planning and aggressive public education efforts will Montana's water utilities be able to maintain financial solvency and adequate service capabilities.

ENGINEERING MASTER PLANS AND THE CIP: THE RELATIONSHIP

Master plans are detailed pre-design level documents. They provide in-depth evaluations of various treatment pumping and distribution system alternatives. The CIP, in contrast, is a more general budgeting and financial programing tool.

This chapter assumes that your community does not have a recent engineering master plan for the water system. If you do not yet have a master plan, the following information will help you determine needs on a rough-cut basis for the purpose of annual budgeting and the five year Mini CIP. It is recommended that you consider doing a master plan sometime in the near future.

If you do have a recent master plan, you may want to skim this chapter and focus on the methods of setting priorities for financing your plan. Having a recent master plan makes for a much more effective Mini CIP.

LIMITATIONS TO NEEDS ASSESSMENT WITHOUT AN ENGINEERING MASTER PLAN

The subject of water supply, treatment, and distribution is very technical and highly variable with differing sets of problems in every system. It is therefore difficult to develop standardized evaluations in a non-technical manner. Basic record keeping practices, as well as distribution system inventory, analysis, and priority setting are functions that can be performed with local staff. Problem documentation and existing condition inventories of treatment, pumping, and storage elements may be completed with in-house staff. **It is recommended that professional engineering expertise be secured for evaluations of highly technical treatment processes and hydraulic calculations. Local officials are encouraged to plan and budget for the more detailed analysis.**

CPE CAN HELP WITH NEEDS ASSESSMENT

As part of your water system analysis, you may want to contact the Water Quality Bureau (WQB) of the Montana Department of Health (444-2406). The WQB has a service called the "Comprehensive Performance Evaluation (CPE)". A CPE can be done for your system and can help you evaluate system needs. The CPE may be able to identify problems which can be fixed without constructing expensive improvements.

THE WATER DISTRIBUTION SYSTEM

In order to effectively plan for improvements to deteriorating water systems it is necessary to discuss the reasons for deterioration. For purposes of this report, the "usual" water distribution system is considered to be made up of the following components:

1. Water mains (including joints)
2. Water services (including corporation stops, curb stops, curb boxes and tapping saddles)
3. Water meters
4. Valves (including main line valves, hydrant auxiliary gates, pressure reducing valves, and air relief valves)
5. Hydrants

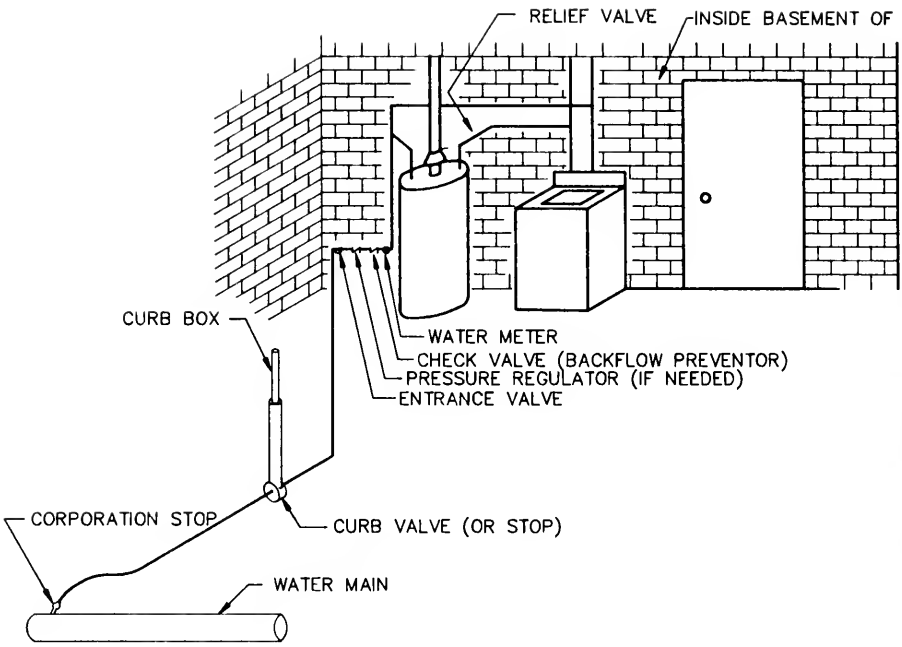
See Figure 3.1 showing typical water system segments.

Main Break Causes

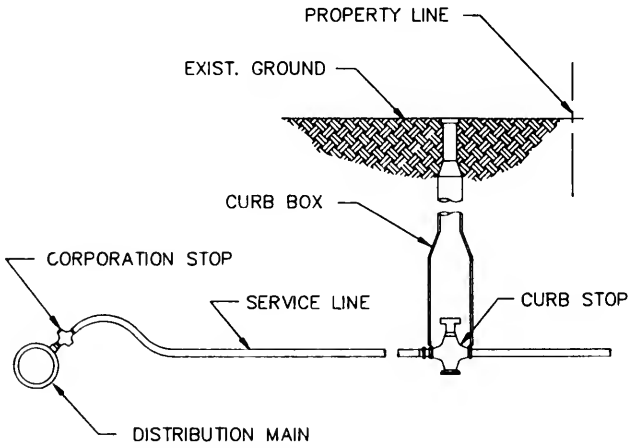
Water mains suffer most from leaks and breaks due to improper installation practices; excessive soil, frost, or artificially imposed loads, corrosion, or specific chemical attack. Point loading, lack of bedding, or nonuniform compaction are known to cause catastrophic pipe failures in asbestos cement, polyvinyl chloride (PVC), and old cast iron pipe. Similarly, high loads imposed by frost heaves or other artificial conditions also cause problems. Chemical attack from leaking underground storage tanks or fuel lines containing Benzene, Toluene, Xlene, Chlorobenzene, Ethers, and Ethyl Halides can damage PVC pipes. These

chemical solvents can penetrate PVC pipes, causing health risks. Corrosion is the primary problem with concrete cylinder and unprotected cast iron or ductile iron pipe. Figure 3.2 shows the sum of all forces acting against a typical water main.

In Montana, predominant water pipe types are cast iron (pre 1964), asbestos cement (1945-1979), and today's PVC and ductile iron. This handbook will be limited to the problems associated with these most common pipe systems.



SERVICE LINE AND CURB BOX INSTALLATION



COMPLETE RESIDENTIAL SERVICE CONNECTION

FIGURE 3.1

Asbestos cement pipe appears to suffer most from uneven or point loading due to improper installation (bedding), differential trench settlement, and corrosion of older galvanized bolted couplings and service saddles. Loading problems can generally be avoided by strictly following manufacturer's installation instructions, and planned replacement of corroded galvanized appurtenances.

Asbestos cement, PVC and poly-wrapped ductile iron pipe appear to hold up quite well in Montana provided that installation specifications are strictly adhered to.

External Corrosion of Pipes and Components

External corrosion appears to be the primary source of concern of our State's water distribution systems. Detailed information of the mechanics of corrosion can be obtained from a water quality engineer. An understanding of corrosion may be necessary in order for the local officials and their engineer to predict economic life of water mains in the absence of good operating records. In other words, if adequate documentation of main breaks is not available, and if the town is hard pressed to establish replacement needs, a knowledge of corrosion is necessary to procure professional engineering expertise in predicting future water main failure rates. Contact an engineer with experience in water line corrosion for assistance.

Internal Corrosion or Clogging of Pipes and Components

In the absence of good historical records, it is advantageous to cut a section of pipe and examine the internal pipe walls for the presence of corrosion or clogging. Unlined gray cast iron mains are particularly susceptible to internal corrosion; causing loss of hydraulic capacity, water discoloration, and loss of main wall. Soft water has reportedly flaked off minuscule particles of asbestos in unlined asbestos cement mains, providing the opportunity for human ingestion (Asbestos causes cancer).

Water flowing through a main may contain both corrosion stimulating and inhibiting factors. These factors complicate the simple internal corrosion process described above. Some of the more important factors that have been discussed by a number of researchers include:

1. Water pH -- A low pH generally accelerates corrosion. "Low" pH means the water has an acidic quality. (Low = 0 to 5.9 pH reading).

2. Dissolved Oxygen -- Dissolved oxygen in water may accelerate corrosion.

3. Buffering Capacity -- An insufficient alkalinity to provide buffering capacity to the water allows formation of protective films.

4. Total Dissolved Solids (TDS) -- Elevated concentrations of TDS increase conductivity and may increase corrosion. TDS are small particles of matter (such as soil) that are dissolved in the water.

5. Silica -- Protective silica films cover metal surfaces under favorable conditions, reducing corrosion and causing scale buildup.

6. Calcium -- Protective films form under favorable conditions, reducing corrosion and causing scale buildup.

7. Phosphates -- Orthophosphates and polyphosphates may form protective films or prevent corrosion.

8. Temperature -- Elevated temperatures may increase the corrosion rate.

9. Water Flow Rates -- High velocities allow oxygen to interact more easily with the surface of the conduit, remove protective films, and cause increased corrosion.

10. Chlorine -- Chlorine may remove the protective films mentioned above and cause increased corrosion.

11. Hardness -- Hard water decreases corrosion and soft water increases corrosion.

12. Iron -- The presence of soluble iron in water will increase the size of tubercules (large particles adhering to the pipe wall) clogging the pipe.

13. Sulfate -- An elevated ratio of sulfate to alkalinity results in conditions favorable to pitting.

Depending on the quantities and combinations of these factors, water quality may be corrosive or noncorrosive. The presence of the above factors in a water distribution system plays an important role in determining the amounts and rates of corrosion to pipes.

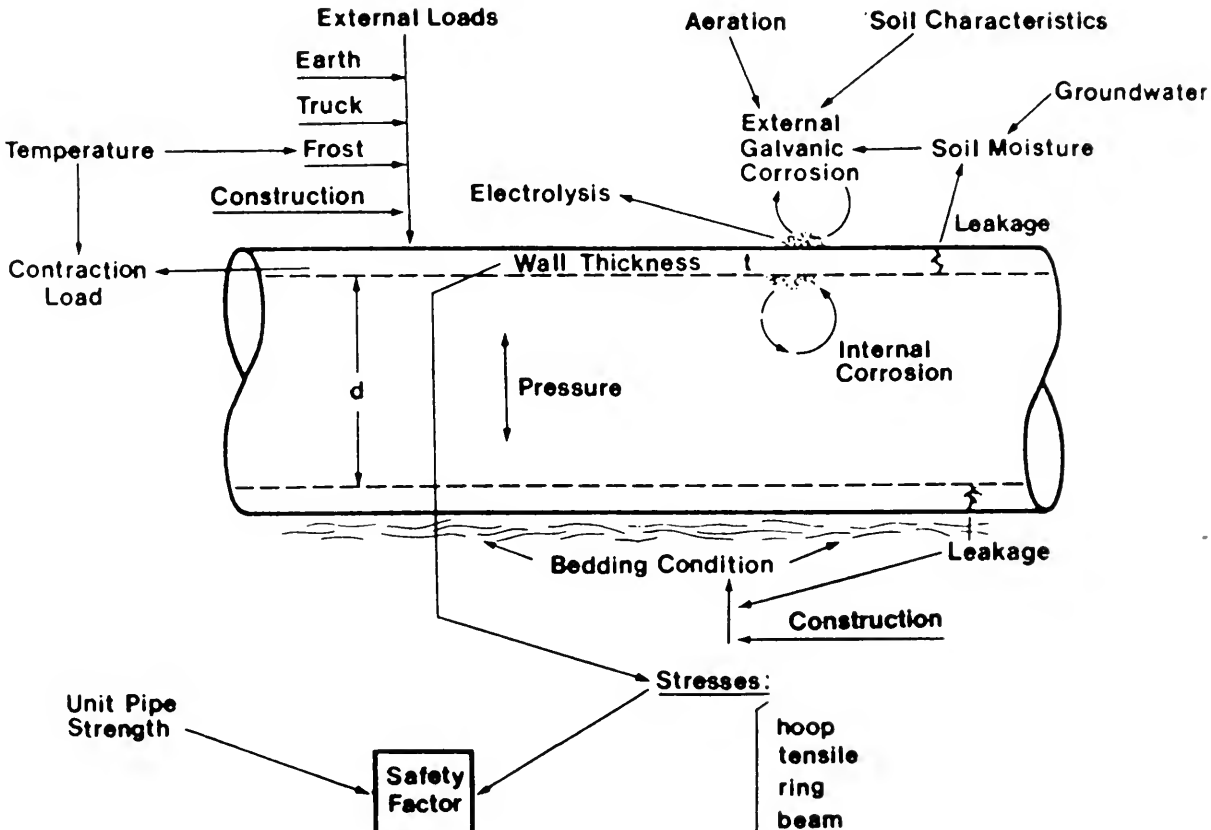


FIGURE 3.2 - CONCEPTUAL MODEL OF WATER MAIN SHOWING STRESSES AND FORCES WHICH CAUSE DETERIORATION OF THE MAIN.

Measuring Internal Corrosion

At present, there is no test available to accurately measure historical internal corrosion at the pipe wall, short of cutting a ring from the pipe. "Coupon weight loss" measurement programs have been started by some communities to assess the relationship between the rate of internal corrosion and the effects of any changes in water quality (a coupon is small section cut out of a pipe). Coupon weight loss programs involve cutting equal size pipe coupons at various locations in the distribution system. The weight of the coupons is then compared to a similar coupon of new pipe.

A second method used to assess water quality corrosion potential is the corrosion index. While a number of indices have been developed, there is no single index that takes into account all thirteen parameters described previously. The Langelier Saturation Index (LSI) is recognized as the best available internal corrosion index in use today, however, it has limitations and is highly technical to use.

Most Montana utility employees do not have "LSI" evaluation expertise. As discussed in the "Evaluation" section of this chapter, mere recognition of an internal corrosion problem by checking weight loss measurements may allow the town's engineer to salvage the pipe system through treatment process control methods or lining. The complexity of internal corrosion requires the use of a professional engineer competent in the water quality field. Community officials are encouraged to contact an engineer for suspected internal corrosion problems.

Hydraulics (Water Movement, Pressure and Capacity)

Hydraulic problems and inefficiencies should also be investigated in developing an inventory of a water distribution system. While there is no substitution for "network analyses" by knowledgeable engineers, measurements can be taken by water distribution personnel to help the engineer calibrate the models developed in the network analyses. Customer complaint logs as well as other "hydraulic inventory items" are provided in the following inventory section. In the event of hydraulic problems (such as chronic loss of water pressure or wild pressure fluctuations) the operator should consider installation of continuously recording pressure gauges along with permanent meter installations at the source of supply. The pressure gauges may be moved around the system to pinpoint problem areas. Hydrant flow tests are a very useful tool in determining hydraulic capacities. Methods for performing the tests are included in Appendix F.

"Water hammer" is one hydraulic problem that leads to other more severe problems. Main breaks may easily be related to these pressure "spikes" which are caused by rapid pump cycling, faulty pump controls, or other related problems. Faulty pump control valves or malfunctioning pump controls may severely shorten the economic life of a water main.

Another major consideration in hydraulic evaluation is anticipation of future demand. In developing areas of Montana, local officials should seek professional engineering expertise for help in forecasting water demands and using those forecasts for the network analysis of the distribution system. Population projections should be obtained from the local planning board or the Montana Department of Commerce, Census Data Center (444-4393).

The final consideration in system hydraulics is pumping efficiency (which is covered in a later section of this report) as it relates to "clogged" piping. Physical evaluation of internal pipe walls should be considered by utilities with a history of hard water, or high concentration of dissolved solids.

We have thus far discussed the elements of the water distribution system. The following section will discuss a simple method to analyze the condition of the system.

CONDITION ANALYSIS - Using the Historical Data Approach to Identify and Inventory Distribution System Problems

Analyzing historical maintenance costs, comparing operating records, and conducting a system inventory are key elements for capital improvements planning. The following procedure is a simple method that local public works staff can use to set repair priorities using maintenance records, such as records of water main breaks.

Items needed to complete water distribution system inventory and analysis include:

1. this handbook;
2. a town or distribution system map (available from your consulting engineer, the county courthouse, or state agencies). In the event a map is unavailable, one should be made by your consulting engineer;
3. multi-colored pins;
4. corkboard;
5. engineers scale and calculator; and
6. extra copies of Table 3.1, and Figures 3.3 through 3.8.

Inventory and Analysis Method

1. Obtain or make a large scale drawing (scale 1 inch equals 600 to 1000 feet) of the as-built distribution system, i.e. valves, hydrants, and mains. (Note: Computer mapping of utilities is becoming possible. Good, easily updated maps simplify the CIP process. For example, one consulting firm has computerized the water distribution system at the Montana Air National Guard Base to facilitate updates of as-built conditions.)
2. Wall mount the map on a cork-backed bulletin board.
3. Purchase several cartons of pins with multicolored heads.
4. For every significant maintenance or repair effort, place a pin on the board at the location of the occurrence. Examples of "significant efforts" are water main breaks, service connections, pump repairs, valve work, etc.
5. Use the same colored pin for each year. Every year, start with a new color. Maintain at least 5 colors on the board at all times.
6. For each maintenance or complaint activity, write up an inventory sheet as shown on Figures 3.3 through 3.8.

The inventory, maintenance, and repair data shown in Figures 3.5, 3.6, and 3.7 are available from water meter suppliers, as well as respective valve and hydrant suppliers. These are available in 3 x 5 card format. The data depicted on Figures 3.4 and 3.8 could also be placed on cards. If the public works staff has a computer they could easily log this information.

By developing a historic data base, a comparison of repair costs versus replacement costs for various waterline segments and other components can be made for further evaluation and prioritization.

It is important to assign realistic costs to necessary repairs. As shown in the following "Evaluation" section, it is necessary to compare true repair/maintenance costs against replacement costs on an "apples to apples" basis. Table 3.1 summarizes all repair costs that must be taken into consideration.

Unit costs should reflect what it actually costs to "do business" as if "contracting out" repairs. This provides a fair comparison of true repair costs versus true replacement costs which is used in the evaluation portion of this chapter.

For a reference, see the Water Main Sample Photographs (Appendix C).

TABLE 3.1

REPAIR COST ESTIMATING

1. LABOR COSTS
   A. Direct Wages....._____

   B. Direct Overhead

   - insurance(unemployment, health)_____
   - vacation costs...._____
   - sick leave costs.._____
   - workmen's comp...._____
   - social security..._____
   - other benefits...._____

(Note: Direct Overhead is usually about 35% depending on workmen's comp. rates.).

   C. Indirect Overhead

   - supervision/administration costs_____
   - shop utility costs _____
   - shop upkeep/rental/maintenance costs_____

(Note: Indirect Overhead is usually about 100% of direct wage costs, or equal to wage costs. This cost must be included because if the need for labor is not present, there would be no need for supervision, a shop, etc.)

2. MATERIAL COSTS
   A. Direct Purchase Costs (Repair Clamps, etc.)_____
   B. Imported Bedding Costs _____

   C. Surface Replacement Cost (Asphalt, Gravel, Curb)_____

   D. Inventory Costs (represents what you can do with your money other than stock materials, usually 8%)_____
   E. Lost Water Costs_____

3. EQUIPMENT COSTS
   - Operating Costs (Gas, Oil, etc.) _____
   - Maintenance Costs _____
   - Replacement Costs _____

4. DAMAGE CLAIM COSTS _____
   (homeowner claims, lawsuits, etc.)

NOTE: Generally labor is charged out at $16.00 to $22.00 per hour. Material costs are readily computed from purchase prices. Equipment costs may be estimated as follows:
- small backhoe - $34.00/hour
- dump truck - $15.00/hour
- pickup - $ 3.00/hour
- loader - $40.00/hour
- compressor - $10.00/hour

EXPLANATION OF TABLE 3.1

An example of estimating unit labor and equipment costs follows:

1. LABOR

A. Direct Wages: 2088 hrs x $7.00/hr = $14,616.00

B. Direct Overhead:

- vacation costs; 120 hrs/yr x $7.00/hr	=	840.00
- sick leave costs; 30 hrs/yr x 7.00/hr	=	210.00
- unemployment insurance (1% of wages)	=	146.00
- FICA (withholding-7% of wages)	=	1,023.00
- PERS (6% of wages)	=	877.00
- Industrial Accident Ins. (6% of wages)	=	877.00
- Health Insurance; $100/month x 12 mos	=	1,200.00
- Union Pension ($0.10/hr)	=	209.00
TOTAL COST OF EMPLOYEE	=	$19,998.00/yr
	=	$9.58/hr

C. Indirect Overhead

- liability insurance: $3,000/yr with 5 total employees, the cost of liability spread over those employees is: $3000.00/5(2088)	=	$0.29/hr
- shop utilities (electricity, gas, sewer, water) is: $1200.00/yr. Spread out over 5 employees the manhour cost is: $1200.00/2088(5)	=	$0.11/hr
- supervision: assume the superintendent spends 50% of his time on direct crew supervision. His cost to the municipality is: $26000.00/yr. Therefore supervision costs for a 2 man crew are: $26000/2(2088)	=	$6.23/hr
- shop rent/upkeep. Say this totals $1200/yr Spreading this cost out over a 2 man crew is: $1200/2(2088)	=	$0.29/hr

Total labor cost per manhour is then summarized as follows:

Labor and Direct Overhead	=	$ 9.58/hr
Indirect Overhead	=	6.92/hr
TOTAL	=	$16.50/hr

2. EQUIPMENT UNIT COSTS:

"Blue Book" equipment rental rates which are "national averages" are available from:

Dataquest, Inc.
1220 Ridder Park Dr.
San Jose, CA 95131
Phone: (408) 971-9000

This book allows you to see what equipment would cost if you must rent it. For in-house calculations, the following must be considered:

- Replacement Cost,	say	$ 7.00/hr
- Depreciation,	say	7.00/hr
- Operating Cost,	say	10.00/hr
- Maintenance Cost,	say	10.00/hr
TOTAL		$34.00/hr

3. MATERIAL COSTS:

The majority of these may be obtained from the supplier. Some, such as lost water costs, may be very important and difficult to assess. (Utilities are encouraged to have a thorough leak detection analysis completed in order to adequately assess lost water costs).

For a typical main break, an example distribution repair report follows Figure 3.3 on a completed form.

FIGURE 3.3
DISTRIBUTION REPAIR REPORT

Work Order No. 1 Condition: X Emergency
Reported Date: 10/1/87 ____ Planned
Repaired Date: 10/1/87

Exact Repair Location: East Prop. Line of 711 Elm Street

Component Repaired:

____ Bolts	____ Service Pipe	____ Line Valve
____ Tapping Saddle	____ Corporation	____ PRC Valve
X Main Break	____ Curb Stop	____ Air Relief Valve
____ Hydrant	____ Meter Pit	____ Hydrant Gate

Description of Work: Repaired main break on split bell by cutting in one length of PVC and two sleeves. No adjacent property damage, no curb destroyed.

Site Conditions: Clay/cinders Soil type
6' x 12' Surface dimension of hole
A.C. (2") Surfacing type

Type of Break: ____ Joint X Split Bell X Corrosion
____ Cir. Break ____ Long Split

Main Condition: Pipe O.D. 6.90"
Pipe Type C.I.P. (sand cast)
Depth Cover 5'6"
Backfilled with blowsand
Internal conditions cement lined, 1/4" scale developed
External conditions very pitted, soft and brittle

ITEM DESCRIPTION	UNIT COST	HRS/ UNITS	EXTENSION	
MATERIALS:				
6" PVC, C900, CL 150	$4.79/FT	18	$86.22	6" X
12" solid sleeve (MJ)	$78.00/each	2	$156.00	
A.C. (tons)	$45.00	1	$45.00	
C.Y. blowsand bedding	$ 3.00	16	$48.00	
C.Y. Gravel	$18.00	1	$18.00	
EQUIPMENT:				
J.D. 410 Backhoe	$34.00	6	$204.00	5
C.Y. Dump Truck	$15.00	6	$90.00	
Pickup	$ 3.00	8	$24.00	
Compressor w/jack hammer	$10.00	3	$30.00	
Wacker	$ 3.00	3	$ 9.00	
LABOR:				
Pete S., Laborer	$16.50	8	$132.00	
Joe M., Operator	$16.50	8	$132.00	

NOTE: Lost (600 gpm x 90 minutes) / 7.48 gallons/CF x $0.40 / 100 CF $29.00

TOTAL $1003.22

FIGURE 3.4

SERVICE INVENTORY LOG

Street Number_____

Parcel Number (or account number)_____

Tap Location_____

Curb Stop Location_____

Date Installed_____

Pipe Type/Size_____

Repair History: Date (/ /) Description:_____

Date (/ /) Description:_____

Date (/ /) Description:_____

Date (/ /) Description:_____

Date (/ /) Description:_____

Date (/ /) Description:_____

FIGURE 3.5

METER INVENTORY LOG

Tap No._____ Address_____

Meter Make_____ Size_____

Location_____ Owner_____

Date Installed_____ Renter_____

Service History_____

_____

Date (/ /) Description:_____

Date (/ /) Description:_____

Date (/ /) Description:_____

Date (/ /) Description:_____

Date (/ /) Description:_____

Date (/ /) Description:_____

FIGURE 3.6

MUELLER CO.

VALVE RECORD

Location _____ No _____

Type _____ Make _____

Size _____ Operating Nut _____

Opens _____ No. of Turns _____

Valve In _____ Route No. _____

Remarks:

_____

_____

Over Form 10296

(Front)

Date	Opens	No. of Turns	Stem	Packing	Nut	Box or Manhole	Valve is Now	Checked By	Remarks

(Back)

Valve Record Cards Available From Mueller Co.

FIGURE 3.7

HYDRANT RECORD

Location_____No._____
Make_____Date Installed_____
Aux. Gate Valve_____Hose Connec. 2-1/2"__Pumper_____
Static Press_____Date_____Residual Press_____Date_____
Flow (GPM)_____Elev._____
Remarks_____

Date	Inspected, Checked, Repaired	Repair Costs

NOTE: Hydrant Record Cards Are Available From Mueller Co.

FIGURE 3.8

CUSTOMER COMPLAINT LOG

Complaint No._____

Date_____

Time_____

Name_____

Address_____

Phone No._____

Type of Complaint_____
_____
_____

Action Taken_____
_____
_____

Date Resolved_____

Remarks (include any costs incurred to resolve such; may refer to work order)_____
_____
_____
_____
_____

NOTE: Use this form for recordation of low pressure problems, generally a source of customer complaints.

After cataloging repair histories, the decision to keep up with repairs or to replace the system component must be made, then a ranking of the replacements is made.

The decision to continue to repair a system segment or replace it is simply one of economics.

As stated previously, there are numerous considerations in assessing repair costs. In addition to the direct and indirect costs listed in Table 3.1 for labor, materials, and equipment, the following must be considered:

1. The value of the water lost through leaks or breaks (including treatment and pumping costs). Leak detection is a very valuable method in aiding the decision making process. Serious consideration should be given to use of leak detection as a CIP tool.

2. Damage claims, with associated insurance and legal costs.

3. Nonmonetary costs and risks, including:
   -- health hazards from foreign materials entering the pipe;
   -- traffic and service disruption;
   -- negative publicity;
   -- lack of fire fighting capability during repair periods; and
   -- compliance with federal and state drinking water regulations

Non-Monetary Considerations

If monetary values could be assigned to the "risky" nonmonetary considerations discussed in Item 3 above, the cost of repairs would skyrocket and result in an "easy" decision favoring replacement. While it is not advisable to attempt to assign a cost to the nonmonetary considerations, they should definitely enter into the final decision making process.

Many economic models have been developed to determine when replacement becomes more cost effective than continuing to make repairs. The economic analysis for repair or replacement consists of determining the number of repairs per year that can be performed before this break-even point is reached. This analysis is based upon direct labor and material costs for both repair and replacement as well as indirect overhead costs.

The economic trade-off between repair and replacement compares the initial cost of replacement with the projected savings of future repair costs. Theoretically, the break-even rate may be defined as the point at which the cost of replacement for a given pipe segment equals the future cost savings of repair. If the occurrence of breaks on a particular pipe section exceeds the break-even rate, it is economically advantageous to replace the main. Conversely, segments with less than the break-even rate may not be candidates for current replacement.

Selection of Pipe Segments to Determine Repair and Replacement Priorities

Choose pipe segments for inventory sections that have similar characteristics throughout their lengths. The following are examples of section boundary points that may be used:

* roadway intersections;
* tees or crosses;
* points where pipe is increased or decreased in size;

- changes in pipe type; or
- significant changes in maintenance requirements, such as the start of a long section buried in cinders which breaks frequently.

Break Even Analysis (Repair vs. Replacement Decisions)

Use the following formula to decide whether to replace or repair each separate pipe.

The break-even situation is presented as:

$$R = C$$

Where:
R = annual worth of expected repair savings.
C = cost of replacement, developed as an annual cost over the life of the project.

When R is greater then C, it costs more money to repair or maintain than to replace the pipe segment.

The annualized replacement cost is developed as follows:

$$C = 1.15 \times P \times (CRF)$$

where P = today's construction cost, developed from a local contractor's estimate, your engineer, or Montana Rural Water Association staff

1.15 P = Today's total Project Cost, including 15% for legal, admin., and engineering

CRF = Capital Recovery Factor from Appendix D, for specific interest rate (i) and period (n). Choose interest equal to current annual bond rates, and period equal to term of debt (bond) retirement.

Annual worth of repair savings, R, is brought forward from the inventory sheets and includes all direct and indirect costs for labor, materials, equipment, lost water, damage claims, and all other costs associated with repairs for the given year.

An example of water main repair/replacement evaluation is shown as follows:

EXAMPLE: (Break-Even Analysis)

Let R = U x B x F

where:
U = average repair cost per main break per year
B = number of breaks per year
F = factor for anticipated growth rate in repair frequency (which may be 10 to 20 percent per year), usually 1.0 to 1.2

from records, U = $1,000.00/break
B = 15 breaks per year (this pipe segment only)
F = 1.10 (from experience and historical records)

therefore R = (1000) x (15) x (1.10)
= $16,500

from MRWA advice, Construction Cost, P, is estimated at $20.00 per foot for the 5000 foot segment under analysis, for a total of $100,000. Current bond interest rates are 10% for a 20 year bond

n=20, i=10, therefore CRF = .1175 (from Appendix E)

C = 1.12 (100,000) (.11746)
= $13,155.52

In this case, R is greater than C, and the main may be replaced more cheaply than it can be repaired and maintained.

The Historical Data Approach For Setting Water Main Repair/Replacement Priorities

Point score or cost benefit analysis methods are normally used in the historical data approach to establish priorities for dealing with problem mains and allocate funding for rehabilitation. Main evaluation methods reflect the utility's current replacement policy based on the system break trends and other criteria. Usually only mains which fail chronically are evaluated. Utilities should track these mains using repair maps described earlier. Utilities should also utilize a maintenance history database to help streamline the evaluation process.

Main Replacement Evaluation - Recording Leak and Break Information

The "historical data" replacement planning system is built around the logging and recording of all leak and break information so that assessments of frequently failing mains can be made. Forms are filled out by repair crews which are then utilized in the evaluation process.

All service and leak complaints are recorded on a Customer Complaint Form. This form is used to record information on the condition related to a reported leak or break. Work orders are used to track all labor, material, and equipment expenses related to repair of major leaks and breaks.

As part of leak or break repair, the repair crew completes on the work order the apparent cause of the leak at the time of service interruption, material required, personnel required, and equipment required.

Once all repairs are made, and the appropriate forms are complete, the forms are filed by street address and date in a central filing system. As part of the filing activity, update the wall map which includes the locations of all leaks and breaks. During the map update step, evaluation is made as to the frequency of reported leaks and breaks. **As a guide, mains with more than three leaks per 600 feet are identified for replacement evaluation.** Evaluate the system's segments using the "break-even" analysis. Those segments proving to be economically feasible as replacement candidates are further prioritized with the numerical rankings on Table 3.3.

Main Replacement Evaluation - Hydraulic Improvements

The utility then evaluates the water distribution system to identify mains that need to be improved for hydraulic reasons. The distribution maps are reviewed to identify specific projects such as dead-ends, low pressure complaint areas, and areas with a sufficient fluctuation in pressure. In addition, those areas in the system which have the greatest pressure loss are identified for evaluation of the need for either cement lining of unlined mains or replacement of these mains. The hydrant flow test methods described in Appendix F and alluded to in the earlier hydraulic discussion of this chapter will be helpful.

Ranking of Mains

The Distribution System Improvement Form, Table 3.3 is used to assign point scores for (or rate) all mains evaluated for distribution system improvement. A discussion of the point scoring system on Table 3.3 is as follows: Points are plugged into Table 3.4 by pipe segment, and segments are then ranked.

1. Economic Considerations: From the break even analysis, compare repair costs (R) to replacement costs (C). If the ratio of R/C is greater than 1.0, then that pipe segment gets 10 points. If the ratio is 0.85, the pipe segment gets 9 points, etc.

2. Depth of Main: Freezing considerations must be taken into account. From repair history work orders, note how much earth cover is over the top of the pipe. Assign point scores according to pipe depths per Table 3.3.

3. Size of Main: Four inch mains with hydrants attached are assigned 4 points, as fire flow capability from these mains is not desirable. If the main is 6 inch, 4 points are assigned.

4. Importance in Grid: Transmission lines to customers that are sole sources of supply are assigned 4 points. Mains that are interconnected at various intervals (street intersections) and that put less than 40 customers out of service are assigned 0 points. Dead end mains with a history of red water complaints should be targeted for "looping" into the system for service adequacy reasons.

5. Pipe Type: This item is self explanatory.

6. Distribution Main Pressure: Using hydrant gauges, sill cock pressure gauge readings, or customer complaint forms, insert an appropriate point score. REMEMBER, MAIN PRESSURE MAY BE A FUNCTION OF UPSTREAM CONDITIONS. IF AN UPSTREAM CONNECTING MAIN IS THE PROBLEM SOURCE (as identified through engineering analysis), THEN THAT MAIN MUST BE ASSIGNED POINTS ALSO.

7. Pressure Fluctuations: From recording gauges, assign points for areas with pressure fluctuations.

Noncompliance with Federal or State Drinking Water Regulations may also be used in the point rating system. System segments out of compliance would receive 10 points, system segments in compliance would get 0 points.

Annual Updates of Distribution System Repair/Replacement Priorities

On an annual basis, review the evaluations using Table 3.4 to develop an overall plan for the upcoming year. Remember that the CIP is a 5 year plan, updated annually. If this is the jurisdiction's first CIP, the initial product is a 5 year plan. Thereafter, one year is "added" annually as the plan is modified to maintain a 5 year planning focus. The following sequence is followed during annual updates.

1. Update construction activity which has occurred during the previous calendar year.

2. Review candidates for main replacement due to corrosion and for hydraulic distribution system improvements.

3. Arrange candidates by point values. (Per Table 3.3).

4. Prepare preliminary list of upcoming replacement candidates.

5. Arrange special jobs based upon scheduling requirements such as paving and other utility construction.

6. Governing body review of preliminary list.

7. Prepare final list. Governing body approval.

The water main replacement evaluation factors and point scores are listed in Table 3.3: **Higher scores indicate water main segments with more problems; lower scores indicate main segments with less problems. A score of ten points is justification for recommended replacement.** Once a main has been recommended for replacement, it will remain on the list of replacement candidates until it is actually replaced.

Using the rating form shown on Table 3.3, summarize the point totals for each pipe segment by completing the form on Table 3.4. Assign preliminary rankings based on the point scores.

TABLE 3.3

DISTRIBUTION SYSTEM IMPROVEMENT FORM

CONSIDERATION	POINTS
A. Economic Considerations	
1. Segments with R/C ratio greater than 1.0	10
2. Segments with R/C ratio from 0.8 to 0.99	9
3. Segments with R/C ratio from 0.6 to 0.8	7
4. Segments with R/C ratio from 0.4 to 0.6	5
5. Segments with R/C ratio from 0.2 to 0.4	3
B. Depth of Main	
1. Depth of Cover less than 3 feet	8
2. Depth of Cover 3 to 4 feet	6
3. Depth of Cover 4 to 5 feet	4
4. Depth of Cover 5 to 6 feet	2
C. Size of Main	
1. 4" Main serving hydrant	6
2. 2" or smaller main (no hydrants) serving more than 3 homes	4
3. 3" main (no hydrants) serving more than 6 homes	4
4. 4" main (no hydrants) serving more than 12 homes	4
5. 6" main serving hydrant	4
D. Importance in Grid	
1. Sole source of supply to customers	4
2. Dead end, needs loop	2
3. Part of strong grid	0
E. Pipe Type	
1. Galvanized or Galvanized appurtenances	5
2. Unprotected Cast Iron	3
3. Other	0
F. Distribution Main Pressure	
1. Less than 40 psi	6
2. 40 to 50 psi	3
3. Over 50 psi	0
G. Pressure Fluctuations	
1. 50 psi	10
2. 40 psi	7
3. 30 psi	4
4. 20 psi	2

TABLE 3.4

DISTRIBUTION SYSTEM

POINT SCORE SUMMARY

PIPE SEGMENT	SCORES							TOTAL SCORE	NUMERICAL RANK
	A	B	C	D	E	F	G		
1. From____to____									
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									
11.									
12.									
13.									
14.									
15.									
16.									
17.									
18.									
19.									
20.									

DATE:_____

TABLE 3.4 EXAMPLE

DISTRIBUTION SYSTEM

POINT SCORE SUMMARY

PIPE SEGMENT	SCORES							TOTAL SCORE	NUMERICAL RANK
	A	B	C	D	E	F	G		
1. From Node A to Node B	7	6	4	2	3	3	4	29	1
2. "B" to "C"	5	4	4	0	3	3	2	21	2
3. "C" to "D"	3	2	4	0	3	3	2	17	3
4. ETC.									ETC.
5.									
6.									
7.									
8.									
9.									
10.									
11.									
12.									
13.									
14.									
15.									
16.									
17.									
18.									
19.									
20.									

DATE: Nov. 20, 1989

Other Non-Point Scoring Criteria

The evaluation system chosen by a local government does not have to be all encompassing; it should be designed to be used as a guideline which can be altered and expanded. The evaluation system will change as priorities in the system change and as new information becomes available. The final decision to replace the main will lie not only in the point score it receives. The decision will be made by a committee of utility personnel and the governing body. Nevertheless, the point score evaluation method is a valuable tool for prioritizing mains for replacement, particularly if there are a large number of deteriorated mains and not enough money to replace all of them.

Some utilities may have a unique problem not covered by the simplified method shown herein. These utilities are encouraged to look at Appendix E for examples of other prioritizing criteria, and use common sense in setting priorities. Every water system has different raw water, hydraulic, and soil conditions.

For example, internal corrosion may be a factor that was not considered as a criteria item. Other "non-point scoring" criteria which may be incorporated are:

1. Are health hazards threatening if improvements are not undertaken?

2. Can adequate (volume) and reliable service be maintained without replacements?

3. Will negative publicity, customer complaints, and public inconvenience cause "irreversible" customer dissatisfaction, and erode customer confidence in the utility?

4. **Is the existing utility system in compliance with State & Federal Drinking Water Regulations? This may be a very significant prioritization factor.**

5. Will proposed projects be compatible with other public works priorities?

Utility management must also assess long term effects of an aggressive replacement program in terms of annual operating costs. As a system is improved, repair costs (including labor and equipment) will dwindle. The net effect may be a reduction in labor needed as well as reduced material inventory costs and reduced equipment purchases.

ALTERNATIVES FOR SETTING WATER DISTRIBUTION SYSTEM IMPROVEMENT PRIORITIES FOR UTILITIES THAT DO NOT HAVE HISTORICAL RECORDS ON WATER MAIN BREAKS

The Problem of No Records of Main Breaks

As previously mentioned the historical data approach to setting priorities assumes that the utility has adequate records on main breaks. But what if the utility has no records or very poor records on main breaks? Many small towns and county water/sewer districts lack records on main breaks. What if many of the mains are 60+ years old and have not yet broken in large numbers, but the utility maintenance personnel suspect major breaks and problems in the near future? How does the utility set priorities for main repairs or replacements?

If no break records exist, utilities need to set up a main break record keeping system for the future. In the meantime, there are other approaches you can use for setting priorities as alternatives to the historical data method.

Engineer's Inventory and Evaluation

In the absence of good historical records on repair activities the utility should strongly

consider hiring an engineer. The engineer can help utility personnel and the governing body to clarify the current condition of the distribution system and the apparent priorities for repair and replacement of water mains and other system components.

Comprehensive Engineering Master Plan Approach

A comprehensive engineering master plan is an accepted and common method that engineers use to identify system problems and recommend repair and replacement priorities. To prepare a comprehensive master plan a good engineering firm will conduct a variety of tests and evaluations on all parts of the system. Computer modeling, hydraulic tests, network analysis, and other sophisticated evaluations are conducted. Where possible, the master plan can also incorporate the historical data approach. For example, a slightly modified version of the point ranking system (Table 3.3) can be included in the master plan.

Financial Depreciation Table Approach

What if your town cannot afford the engineering master plan and has no records of main breaks? How do you set repair and replacement priorities? Another valid approach is to use a financial depreciation table to roughly estimate water main replacement needs. Accountants and engineers have developed rough estimates of how many years an "average" water main will last in the ground. This information has been converted into tables that engineers, accountants, planners, and utility maintenance personnel can use to estimate when a utility's mains need to be replaced. Accountants and engineers working on behalf of National Rural Water Inc. and the U.S. Farmers Home Administration have estimated that the "average" water main will last 40 years. Thus, any water mains that are older than 40 years may have to be replaced. You can roughly estimate which mains in a water system need to be replaced with this rough and simple method.

The use of a depreciation table must be combined with an inventory and inspection of the distribution system by an engineer and the utility maintenance personnel. The life-span of water mains is dependent on many factors such as soil types, water quality, hydraulics, and the susceptibility of the material from which the pipe is made to corrosion. Thus, the standard 40 year figure may have to be modified based on your inventory.

For details on depreciation tables see Chapter 6, "Raising The Money" and also see Appendix I.

Predictive Approach For Specific Mains

Another approach is called the predictive approach for specific mains. This method uses a variety of tests to examine the corrosion processes at work on specific water main segments. Projections of the remaining useful life (if any) of the mains are made. Thus, mains that should be replaced can be identified.

The predictive approach may require soil corrosiveness tests. Cutting small pieces ("coupons") from water mains to sample the degree of main deterioration may be necessary to determine how many years of service life the mains have.

Unfortunately, the predictive approach requires scientific expertise that many small towns do not have available to them. The American Water Works Association in Denver is conducting research to make the predictive approach more practical.

CASE STUDIES ON SETTING WATER DISTRIBUTION SYSTEM IMPROVEMENT PRIORITIES

In Appendix E three case studies are presented. The case studies show various methods that can be used to set priorities for water main improvements.

WATER TREATMENT, PUMPING, AND STORAGE EVALUATION

This section will deal with regulations, inventory and record keeping procedures, and provide an overview of the evaluation and prioritization processes.

Regulatory Issues in Water Treatment

In 1987, Congress passed significant amendments to the federal Safe Drinking Water Act. Financial ramifications, if the act is implemented as currently intended, will be very significant for small utilities. Testing and reporting requirements alone for various trace chemical and contaminants may exceed current operating budgets. Utilities are encouraged to keep pace with changing regulations through American Water Works Association, Montana Rural Water Systems, and the Montana Water Quality Bureau. EPA has set regulatory standards for the following areas:

- -- V.O.C.'s (Volatile Organic Contaminants, such as Gasoline, etc.)
- -- public information requirements
- -- ban on lead pipe and joint compounds
- -- filtration requirements
- -- primacy for Indian Reservations
- -- inorganic contaminants
- -- disinfectants and by-products

While budgeting for regulatory compliance is not always possible it must be considered in long term financial planning.

Water Treatment Evaluation - Engineer Needed

Water treatment process control evaluation and pumping system evaluations are technical subjects and as such cannot be simplified to layman's terminology. The water treatment industry is constantly changing. For these reasons, it is recommended that actual evaluation of water source development, pumping, and treatment processes be left to the community's engineer. Varying water sources with highly variable raw water conditions and different types of problems preclude adequate assessment in this document.

Water utilities can best aid the engineer by keeping detailed operations and maintenance records for evaluation purposes. Adequate inventory and record keeping saves design dollars, assures a better quality design, and eliminates "guesswork" and assumptions on the part of the engineer. The operating records are also of obvious value to the treatment plant manager from an operational efficiency standpoint and will show variations in operating trends that may be of concern. For example, periodic "wire to water" pump efficiency curve development allows the utility to gauge the need for pump rehabilitation or replacement.

Well Tests

There are several types of well tests. All are quite technical in nature, require specialized equipment, and are not generally within the capabilities of most utilities. It is therefore recommended that pumped-well tests be completed by someone familiar with the calculations and equipment necessary to perform all tasks efficiently, safely, and correctly. For discussion purposes, the procedure is outlined below.

Well tests are needed to determine water quantity, aquifer characteristics, well and pump performance, and pump and motor maintenance requirements.

All pumped well tests require three basic measurements:

1. flow rate

2. static and dynamic water levels

3. elapsed time

Flow rates are determined by:

1. filling a container of known volume for a measured time period; or

2. in-line metering over an elapsed time; or

3. orifices or velocity probes. An orifice is a calibrated hole in the center of a flatplate mounted in the discharge line. Flow rates are calculated using tables for appropriate pipe, orifice sizes, and measured pressure differential across the orifice. Proprietary velocity tubes can be inserted in discharge piping, and calculation of flow rate (Q) is made simply from a velocity (V) x area (A) calculation.

Water level measurements are done by one of three methods:

1. The tape method provides for insertion of a chalk dusted tape into the well from a referenced datum to the water level. The tape is pulled from the well, and the immersion depth is measured. In some cases, the tape may be fitted with a float and lowered until slack occurs.

2. The air displacement method involves insertion of an air line into the water, with a pressure gauge and air pump attached. The air pressure required to empty a line extending into the water equals the pressure exerted by the water column on the outside air. When fully displaced the air line pressure corresponds to the depth of water (between the bottom of the air line, which is a known elevation, and the freatic water level).

3. Electrical sounding is the most common level measurement taken. Sounders consist of a pair of wires, which when contacted by water, complete a circuit. Calibrated marks on the wire indicate the depth to water. Extreme care should be taken to avoid wrapping the wires around the pump column. A small diameter plastic pipe should be inserted down the pipe column for this purpose. Sounding equipment is available from your water equipment supplier.

Well tests include specific capacity, constant rate, and step-draw-down-and-recovery tests. The test results tell us important things about the nature of the aquifer and provide information on the functioning of the pumping equipment. When a well is pumped, the level of the water table in the vicinity of the well will be lowered. This lowering is called "draw-down", as shown in Figure 3.7.

Specific capacity tests measure the variation in water level draw-down with an increasing flow rate. Constant rate tests measure the variation in water level draw-down overtime as a well is pumped at a constant rate. Step-draw-down tests involve pumping a well at a series of constant rates, each larger than the previous rates. The raw data from each type of test is then used in a series of detailed computations for prediction of well characteristic curves. Readers interested in a more detailed explanation of well tests should see "Improving Well and Pump Efficiency" published by AWWA and written by Helweg, Scott, and Scalmanini. (Call AWWA at 1-303-784-7711 to order this book.)

Comparison of well test data allows for evaluation of signs of deterioration. **Typically, screen clogging is the major problem. Chemical analysis of the water may identify the clogging source.**

Pump Capacity Tests

To test a pump it is necessary to develop pump curves. Pump curves (which are plots on a graph of discharge pressure versus flow) should be obtained for all new installations. New head versus discharge curves should be developed on a periodic basis to check for efficiency changes. See Appendix G for pump testing ("pump curve") procedure.

Similar to the work orders shown in the Water Distribution section of this Chapter, pump servicing should be documented as shown on attached Figure 3.9.

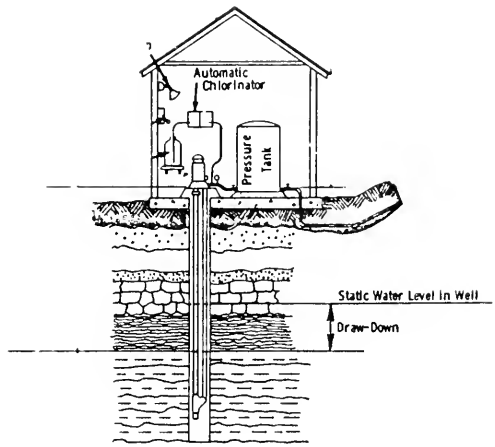
"Wire to water" pump tests gauge the efficiency of an electric motor by measuring input power versus output power.

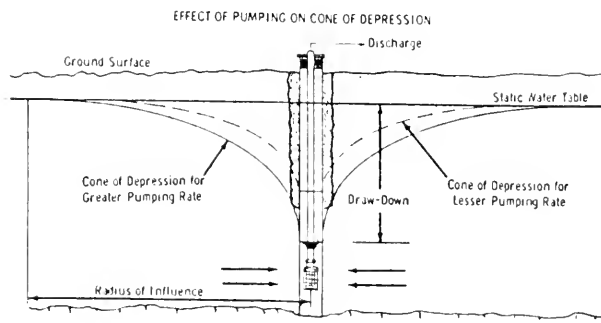
Wire to water tests should be done annually to calculate pump efficiency. Annual repair costs should be logged (including equipment, labor, and materials costs as discussed under water distribution), and an annual pump operating cost developed. When the annual cost of operating the current pump (including electricity) exceeds the annualized cost of a new, more efficient unit the replacement should be made. See Appendix I for wire to water pump efficiency and pumping cost calculations.

Setting priorities for pump repairs or replacement must be addressed by common sense methods. Is the pump part of a duplex station? Will the station pumping capacity meet demands if a single pump is taken off line for extensive repairs? Are other system improvements, such as main replacement, more critical due to their higher monetary repair costs? These questions must be answered individually.

FIGURE 3.7

WELL DRAW-DOWN





Source: EPA Manual of Individual Water Supply Systems

Pump Energy Efficiency

Overall energy efficiency of treatment plants and pump stations should be addressed in the CIP. Contact the Montana Department of Natural Resources and Conservation, Energy Division, 444-6697, or your engineer for additional information.

Treatment Plant and Pump Station Equipment Evaluation

Treatment plant evaluation is a very technical subject. The following is a brief overview as to what goes into a plant evaluation and is provided for the reader as background information only. **The community's engineer should perform process control evaluations. The utility should keep detailed records to help the engineer do his job more effectively.**

Normal existing plant evaluation processes start with three basic questions:

1. **What is the quality and quantity of the given source?** Operating records are very important here in order to avoid expensive data gathering and testing.

2. **What is the projected demand?** The hydraulic analysis mentioned in the water distribution discussion should also address this concern. The answer lies with projected community growth rates and consumption patterns. This data may be available from local or state planning officials and from good utility operating records.

3. **What flows and water quality parameters can the existing facility handle?**

Plant evaluation should begin with a thorough hydraulic evaluation. Testing or checking records of raw water quality parameters and an appraisal of existing process control equipment should follow. The process control equipment should be assessed for it's ability to handle raw water conditions at peak demand flow rates as well as it's economic life.

A typical full scale (surface source) treatment plant evaluation may include:

* Hydraulics -- plant capacity and hydraulic profile
* Initial mixing -- efficiencies and methods
* Flocculation -- efficiencies and methods
* Clarification -- efficiencies and methods
* Filtration -- rates, head loss, filter performance
* Quality Criteria -- turbidity, color, organics, microbiology, taste and odor, corrosion, pH
* Chemical Feed -- efficiencies and methods

Water plant and pump station equipment, including chemical feed pumps and motors, valves, compressors, backwash systems, and control systems should be monitored for repair costs. As shown on Figure 3.9, each equipment item should have a card with repair histories and costs. During annual budget review, all direct and indirect costs associated with repairs should be evaluated against equipment replacement costs.

Figure 3.9

SAMPLE EQUIPMENT INFORMATION CARD (front)

Equipment _____

Location _____

Equipment No. _____ Serial No. _____

ELECTRICAL OR MECHANICAL INFORMATION:

Model _____ Size _____ Type _____

Voltage _____ Amps _____ RPM _____

Capacity _____ _____ _____

Original Installation Date _____

Supplier Information _____

_____

_____

ERVICE ATE	REMARKS	SERVICE DATE	REMARKS (back)

Setting priorities within the CIP matrix takes place similar to the discussion on pump replacement. The utility must judge the relative importance of each system segment and assign a replacement priority to it.

As previously discussed, treatment options are so widely variable for differing raw water conditions, and so technical in nature that they cannot be addressed within the scope of this document. The utility should keep records on the following water system characteristics to aid the community's engineer in evaluating the system:

a. temperature (record daily)
b. turbidity
c. pH
d. Chlorine residual
e. length of filter run (and notation of unusual operating conditions affecting length of run)
f. chemical feed rates and changes thereto
g. unusual raw water phenomena such as algae, fecal coliform, high BOD, etc. (record plant performance during unusual raw water conditions)
h. detention times
i. variable hydraulic conditions (such as river stage, reservoir level, etc.)
j. daily, weekly, monthly, and annual water demand
k. ambient weather conditions

With complete operating records, the professional engineer may make much better decisions with less "guesswork". Complete operating records will reduce the costs of analysis and allow the engineer to produce a more effective design for system improvements.

Storage Tank Evaluation

Storage tank evaluations must be completed by an experienced inspector. Some utilities may have this capability in-house. See Table 3.5 for the items that should be checked regarding tank condition.

Unfortunately inspections of water tanks in many communities indicates that water tank painting and level control is either inadequate or ignored. It is usually performed on an emergency basis only after severe problems have developed. Several things should be considered in developing a total tank system improvement program.

First, all tanks should be inspected periodically. Initially, after a tank has just been painted, the warranty provisions of the contract should be strictly adhered to.

Second, brief inspections should be completed annually, with detailed (interior draw-down) inspections completed every 3 years or less. Repairs at that time should be minor.

Third, complete inspection and remedial work records would be maintained to monitor the status of the paint, structure, and level control system. When remedial work exceeds the capabilities of maintenance personnel, a qualified firm should be hired to inspect the tank, plan repairs, and provide cost estimates for funding of improvements. For informational purposes, a typical tank inspection checklist is shown on Table 3.5. Interested readers are also encouraged to read AWWA Standard D101, Section 3.1, for "Items to be Reported" while inspecting steel water reservoirs.

The actual decision on spot paint repairs versus total repainting must be based on the extent and nature of steel pitting and the type of existing paint coating. After this technical evaluation, the utility may once again establish priorities for tank rehabilitation in comparison with all of the other capital needs of the utility.

TABLE 3.5
TANK INSPECTION CHECKLIST

1. Check vent screens, overflow pipes and hatch covers for security.
2. Inspect interior and exterior ladders and safety equipment.
3. Inspect balconies and platforms for ponded water, corroded deck plates, safety regulations, bolts and rivets.
4. Inspect roof areas for ponded water.
5. Inspect cathodic protection system components.
6. Check operation gauges and pump limit switches.
7. Examine wall-roof joint for leakage and signs of concrete deterioration.
8. Examine underside of roof slabs for leakage.
9. Examine interior and exterior coatings for holidays, rust stains, and pitting. Examine rivet heads for corrosion losses.
10. Inspect walls for cracks and condition of joint material.
11. Determine if scaffold brackets are present. Check their condition.
12. Inspect pockets for trapped-moisture and debris.
13. Inspect all steel and connections for corrosion.
14. Inspect gauges, rectifiers, lights, shutoff valves, etc.
15. Check anchor bolts for corrosion and tightness, check grout.
16. Check floor of reservoir for sediment and debris.
17. Check column shoes for corrosion.
18. Examine tower posts for alignment, foundation settlement, sway rod adjustments, rust, bolt and rivet condition.
19. Examine rod pins, cotter pins, nuts, threads.

Temporary Options For Setting Water Treatment And Storage Improvement Priorities For Utilities Which Lack Sufficient Funds To Hire An Engineer

If the community is currently unable to pay for an engineer's evaluation of water treatment and storage, what alternatives exist to roughly estimate treatment and storage needs? First of all, the local officials should make every conceivable effort to obtain professional engineering assistance. Raising local user fees or taxes in order to obtain the funds for engineering must be seriously considered. In addition, local officials should contact state and federal water system funding agencies for assistance. Some of these agencies may provide loans for communities unable to finance preliminary engineering with local funds. (See Chapter 6).

Secondly, the local officials should contact the Montana Department of Health Water Quality Bureau (WQB) at 444-2406. The WQB may have data, inspection reports, and other information on your storage system and treatment plant. They may be able to provide general information on the nature of improvements needed.

One last option is the use of a depreciation table. Depreciation tables have been developed by engineers and accountants which roughly estimate the useful life of treatment plants and storage. Using a depreciation table is not precise engineering analysis. Instead it is a rough financial planning tool. See Chapter 6 and Appendix I for details on depreciation tables. The use of a depreciation table is not a substitute for an engineer's inspection of your system.

At some point the utility will be legally required to hire an engineer if major improvements to water treatment are necessary. State and federal laws require the hiring of engineers under certain circumstances. For further information contact the WQB at 444-2406.

SUMMARY

In summary, all parts of the water system should be evaluated and repairs prioritized on an annual basis for inclusion in the ongoing five year capital improvements plan. See Table 3.6 to make sure all elements of the system are included in the planning process.

First, a solid data base must be developed to define, monitor and summarize O & M costs in all areas.

Second, the data is evaluated for ranking of individual projects in priority order. Finally, the list or matrix of needed water improvements should be typed in draft form. Table 3.7 is an example of a draft water system improvement priorities list.

As shown in Chapter 5, water projects must then be evaluated and fitted into the larger Mini CIP.

TABLE 3.6

WATER SYSTEM EVALUATION CHECKLIST

For reference, see Figure 3.1. The following items should be inspected and checked to determine at what point repairs or replacement will be needed.

1. pipe systems (include bolts)
2. valves (air relief, pressure relief, gates)
3. hydrants
4. services (include saddles, corporation stops, curb stops)
5. plant and water treatment equipment (pump equipment, feed systems, process control equipment, metering and record keeping, electrical, mechanical, etc.)
6. vehicles and rolling stock
7. laboratory equipment, supplies, or services
8. meters, reading equipment, billing software, repair parts
9. administrative and office needs (including computers)
10. miscellaneous hand and power tools
11. grounds keeping equipment
12. specialized services -- leak detection, rate studies, detailed master plans, computer help, plant evaluation, etc.
13. new growth and development related items (results of network analyses and master plans) system enlargements and extensions
14. upgrades for regulatory changes (Safe Drinking Water Act amendments)
15. tanks (paint, structural elements, foundations)

TABLE 3.7

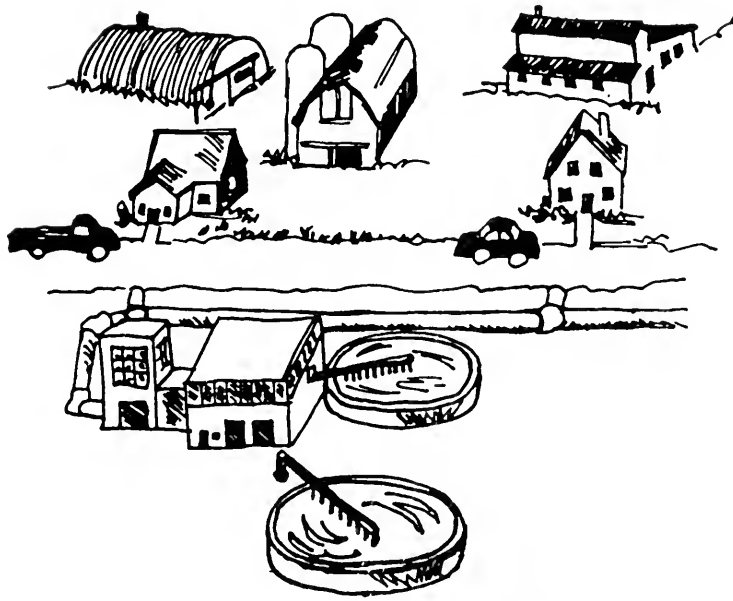
PRELIMINARY WATER SYSTEM IMPROVEMENT PRIORITIES

MAY 1988

	FY 88	FY 89	FY 90	FY 91	FY 92
I. CONSERVATION					
A. Meters	$ 37,000	$ 37,000	$ 20,000	$ 20,000	0
B. Tapping Saddle Replacement	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000
II. WATER MAIN RECONSTRUCTION					
A. Replacement -					
Main Street	$400,000				
Maple Street				$ 70,000	
2nd, 5th Avenue				$ 80,000	
B. Extension -					
Westside					$ 77,000
III. PLANT MODIFICATIONS					
A. Clarifier Rehab.		$ 37,000			
B. Energy Conser. Improvements		$ 40,000			
C. Chemical Storage Rehab.		$ 17,000			
IV. BOOSTER STATIONS/TANKS					
A. East Booster Tank Repair			$ 75,000		
B. Telemetry Changeout			$ 15,000		
C. 33rd Street Transformer			$ 9,000		
V. SPECIAL PROJECTS					
A. Hydrant Changeout					$ 17,000
B. Highway/Utility Conflicts					$ 10,000

CHAPTER FOUR

WASTEWATER SYSTEM NEEDS ANALYSIS



OVERVIEW OF CHAPTER

The purpose of this chapter is to provide an inventory and evaluation method as well as prioritization procedures for planning improvements to wastewater (sewage) collection, treatment, and disposal systems. The method outlined is a model that has been tested and used in some Montana cities and towns. However, your engineer or public works director may recommend an alternate system which is appropriate to the needs of your community

THE IMPORTANCE OF ADEQUATE WASTEWATER SYSTEMS

The average citizen takes sewage disposal and treatment for granted. Most feel simply that they flush their toilet and the problem is gone. Few realize the importance of adequate wastewater treatment and collection in terms of:

1. Reduction of health hazards. Inadequate or improper treatment, or capacity may result in sewer backups, raw sewage diversions to receiving streams, and epidemic type outbreaks of hepatitis, cholera, and other water borne diseases. These human diseases are very serious. They are life threatening.

2. Impacts to water quality in the receiving stream. Recreational and other uses of surface water may be adversely affected by inadequately treated wastewater plant effluent.

3. Economic development potential. Business location and expansion decisions may be affected by the lack of adequate wastewater facilities.

4. Property damage. Sewer backups cause property damage, high insurance rates, poor customer relations, and health hazards for the public.

It is therefore essential that public wastewater systems be managed for health, welfare, recreation, and community development purposes.

Prior to the mid 1950's, most communities in the nation dumped raw sewage into receiving streams. With the advent of the U.S. Public Health Service, larger communities initiated primary treatment, and smaller communities constructed lagoons. The creation of the U.S. Environmental Protection Agency in 1970, followed by the passage of the Federal Clean Water Act of 1973, demonstrated the desire of the American public to clean up the environment and restore water quality in America's lakes and rivers. Wastewater problems now occur primarily in the following areas:

1. Age and lack of maintenance of older wastewater systems.

2. Lack of operator education in operating and maintaining more sophisticated modern treatment and pumping systems.

3. Lack of long term maintenance funding due to apathy of utility managers, taxpayer resistance, economic distress, or a political unwillingness to pursue additional funding.

4. Community growth resulting in overloaded facilities.

5. Pollution of drinking water wells by septic systems.

The Federal Clean Water Act's National Pollutant Discharge Elimination System (NPDES) requirements and the Montana Department of Health's Administrative Rules define surface water quality standards for community systems in Montana. Utilities must be aware that the force of law and legal penalties exist for those communities in violation of these

standards, and that the standards were created through the outcry of the general public to provide safe clean water. For further information on how these regulations affect your wastewater system contact the Montana Department of Health, Water Quality Bureau (444-2406).

In 1991 the Montana Department of Health and Montana Department of Commerce estimated that there is a 132 million dollar need for community wastewater rehabilitation or construction in Montana. Due to a lack of comprehensive data, real needs may exceed 132 million dollars.

Increasing competition for shrinking state and federal grant and loan dollars and locally distressed economic conditions make careful planning absolutely essential. Local government officials must have well documented reasons for increasing utility rates.

ENGINEERING MASTER PLANS AND THE MINI CIP: THE RELATIONSHIP

Master plans are detailed pre-design level documents. They provide in-depth evaluations of various treatment, pumping, and collection system alternatives. The Mini CIP, in contrast, is a more general budgeting and financial programming tool.

This chapter assumes that your community does not have a recent master plan for the wastewater system. If you do not yet have a master plan, the following information will help you determine needs on a rough cut basis for the purpose of annual budgeting and development of the five year Mini CIP. It is recommended that you consider doing a master plan sometime in the near future.

If you do have a recent master plan, you may want to quickly review the first few pages of this chapter and focus on the methods of setting priorities for financing your plan. Having a recent master plan makes for a much more effective Mini CIP.

LIMITATIONS TO NEEDS ASSESSMENT WITHOUT AN ENGINEERING PLAN

Wastewater collection, treatment and disposal is at times technical in nature. It is difficult to provide a "standard method" for evaluation of treatment and hydraulic evaluations in a manner understandable to lay persons. Professional engineering expertise should be secured in those areas which local utility management feels uncomfortable. The local utilities are strongly encouraged to document problems and keep records on existing wastewater loading conditions and effluent quality in order to aid their engineer on defining specific problems.

CPE CAN HELP WITH ASSESSMENT

As part of your wastewater system analysis you may want to contact the Water Quality Bureau (WQB) of the Montana Department of Health (444-2406). The WQB has a service called "Comprehensive Performance Evaluation (CPE)". A CPE can be done for your system and can help you evaluate system needs. The CPE may be able to identify problems which can be fixed without constructing expensive improvements.

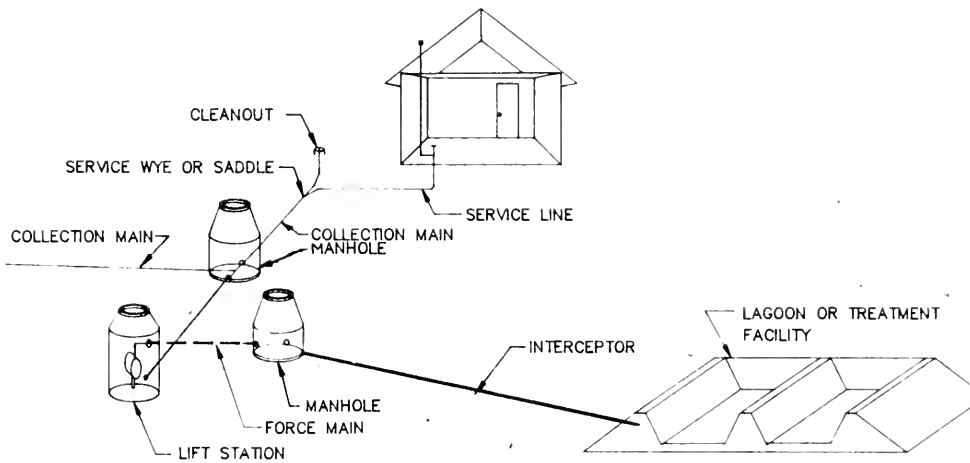
THE COLLECTION SYSTEM

The following section will address inventory and evaluation methods, as well as methods to set repair and improvement priorities for the wastewater collection system.

A "typical" wastewater system is shown on Figure 4.1. For the purposes of this report, a "typical" wastewater system is described as follows:

1. treatment system (plant or lagoon)
2. interceptor and collector pipe systems

3. service lines or laterals
4. appurtenances (manholes, wyes, cleanouts)
5. lift stations



TYPICAL WASTEWATER SYSTEM
FIGURE 4.1

Problem Causes

In order to effectively plan for improvements to deteriorating or undersized systems it is necessary to discuss the reasons for such deterioration or hydraulic overload. The problems are briefly identified as follows:

1. Pipe blockages or failures
    a. root intrusion
    b. defective or improperly installed service saddles (including protruding taps)
    c. leaky joints, causing groundwater intrusion resulting in a loss of pipe bedding material into the pipe as well as initiating infiltration
    d. inadequate grades or "swales" in the pipeline, caused by loss of bedding through joints, improper construction, unusual loading conditions
    e. vandalism at manholes or pump stations
2. Access problems
    a. poorly placed manholes that cannot be reached by cleaning equipment
    b. a lack of manholes, especially on dead end mains
3. Safety problems
    a. corroded manhole steps
    b. lack of manhole steps
    c. lack of safety equipment or procedures
4. Corrosion
    a. hydrogen sulfide generation causing internal corrosion of unprotected concrete pipes
    b. chemical attack on PVC pipes and all pipe gaskets in industrial areas with leaking chemical or fuel tanks
    c. electrolytic or galvanic corrosion of metallic (cast iron or steel) pipes and bolts (usually on force mains) from aggressive soils - See Chapter 3 for a detailed discussion of this phenomenon.
5. Hydraulic Overloads
    a. new development in previously vacant areas
    b. pipe blockages (see item 1 above)
    c. excessive inflow (from manholes, roof leaders, or storm drain inlet connections)
    d. excessive infiltration from leaking joints

Condition Analysis - Using the Historical Data Approach To Identify Wastewater Collection System Problems

The following section shows how to analyze the condition of the wastewater collection system, using historical data on wastewater system repairs and problems.

The method used to select projects for rehabilitation or new construction is as follows:

1. First, document historical maintenance costs, operating records, and system problems. This is explained further on succeeding pages.

2. Second, the data base is used to compare current repair cost to future replacement cost for all pipe segments in the system.

3. Third, pipe segments are evaluated and priorities are set for replacement based upon the ratio of repair versus replacement cost.

4. Fourth, other factors are utilized to further set priorities for replacements, such as the importance of the system segment.

5. The end result is a prioritized list of projects, with cost estimates and funding options assigned for each.

Inventory and Analysis Method

A simplified and workable approach to developing a "list of problems based on historical data" is shown as follows:

1. Obtain an engineer's scale, a scaled map of the sewer system, a calculator, pins, and extra copies of the blank forms shown in Figures 4.2, 4.3, and 4.4.

2. Obtain or make a large scale drawing (scale 1 inch equals 600 to 1000 feet) of the as-built collection system.

3. Wall mount the plan on a cork-backed bulletin board.

4. Purchase several cartons of pins with multicolored heads.

5. For every significant maintenance and repair activity, place a pin on the board at the location of the occurrence. For example, place a pin for every sewer main break that has been repaired.

6. Use the same colored pin for each year. Every year, start with a new color. Maintain at least 5 colors on the board at all times. (i.e. maintenance efforts for 5 years)

7. Associated with each maintenance or complaint activity, write up an inventory sheet as shown on Figures 4.2 through 4.4.

It is important to assign realistic costs to necessary repairs. As shown in the following Evaluation section, it is necessary to compare true repair/maintenance costs against replacement costs on an equal economic basis. Table 4.1 summarizes all repair costs that must be taken into consideration.

Unit costs should reflect what it actually costs to do repairs if repairs were contracted out. This provides a fair comparison of true repair costs versus true replacement costs which is

used in the evaluation portion of this chapter. An example of estimating the actual costs "to do business" is shown.

Other Evaluation Methods

Other evaluation methods are available, which require the use of specialized equipment or engineering expertise. The two methods we will discuss are "televising" and "infiltration and inflow".

Televising

In addition to recording O & M costs and problems via Figures 4.2, 4.3, and 4.4, it is highly recommended that the wastewater collection system be televised. "Televising" is a technique where a miniature television camera is pulled through a sewer pipe. The camera records detailed information on pipe breaks and other problems for later playback and analysis in the office. This process is relatively inexpensive yet provides a great deal of information. For example, cracked pipe or "swales" may exist which have not yet caused system failures, but most likely will. The utility can then plan for long term rehabilitation in addition to short term requirements for existing problem resolution.

Infiltration and Inflow (I/I)

It is also recommended that recording hour meters be installed on all pumps. This concept will be discussed in more detail in the "Treatment and Pumping" portion of this chapter, but is discussed here as it relates to pipe condition. Hour meters with chart recording capability, or some other method such as chart recorded discharge pressure or flow, should be installed at all lift stations. This data allows analysis of night time and storm event flows through each lift station.

Evaluation of this recorded data allows an engineer to accurately assess the extent of infiltration through pipe and manhole joints, as well as inflow from storm inlets, manhole lids, and roof leaders. Infiltration and inflow (I/I) may cause overloading of sewers and treatment facilities. These overloads may cause "sewer backups" in basements and discharge of untreated or partially treated sewage. I/I therefore may cause property damage or discharge permit violations, resulting in property damage claims, law suits, and fines.

Utilities must plan to remedy I/I problems by methods such as separation of storm sewers, enlarging sewer lines, or increasing treatment capacity.

TABLE 4.1

REPAIR COST ESTIMATING

1. LABOR COSTS

   A. Direct Wages....._____

   B. Direct Overhead

   - insurance (unemployment/health)_____
   - vacation costs_____
   - sick leave costs_____
   - workmen's comp._____
   - social security_____
   - other benefits_____

(Note: Direct Overhead is usually about 35% depending on workmen's comp. rates).

   C. Indirect Overhead

   - supervision/administration costs_____
   - shop utility costs_____
   - shop upkeep/rental/maintenance costs_____

(Note: Indirect Overhead is usually about 100% of direct wage costs, equal to wage costs. This cost must be included because if the need for labor is not present, there would be no need for a shop, etc.)

2. MATERIAL COSTS

   A. Direct Purchase Costs (Repair Clamps, etc.)_____

   B. Imported Bedding Costs_____

   C. Surface Replacement Cost (Asphalt, Gravel, Curb)_____

   D. Inventory costs (represents what you can do with your money other than stock materials, usually 8%)_____

3. EQUIPMENT COSTS

   A. Operating Costs (Gas, Oil, etc.)_____

   B. Maintenance Costs_____

   C. Replacement Costs_____

4. DAMAGE CLAIM COSTS_____

EXPLANATION OF TABLE 4.1

An example of estimated unit labor and equipment costs follows:

1. Labor

   A. Direct Wages: 2088 hours x $7.00/hour = $ 14,616.00

   B. Direct Overhead:

- vacation costs; 120 hours/yr x $7.00/hour	=	840.00
- sick leave costs; 30 hours/yr x $7.00/hr	=	210.00
- unemployment insurance (1% of wages)	=	146.00
- FICA (withholding-7% of wages)	=	1,023.00
- PERS (6% of wages)	=	877.00
- Industrial Accident Ins. (6% of wages)	=	877.00
- Health Insurance; $100/month x 12 months	=	1,200.00
- Union Pension ($0.10/hour)	=	209.00
TOTAL COST OF EMPLOYEE		$ 19,998.00/yr
		9.58/hr

   C. Indirect Overhead

- liability insurance: $3,000/year with 5 total employees, the cost of liability spread over those employees is: $3,000.00/5 (2088)	=	$ 0.29/hr
- shop utilities (electricity, gas, sewer, water) is: $1200.00/yr spread out over 5 employees - the manhour cost is: $1,200.00/2088 (5)	=	0.11/hr
- supervision: assume the superintendent spends 50% of his time on direct crew supervision. His cost to the municipality is $26,000/yr. Therefore supervision costs for a 2 man crew are: (0.5)(26,000)/2(2088)	=	3.11/hr
- shop rent/upkeep. Say this totals $1,200/yr. Spreading this cost out over a 2 man crew is: $1,200/2(2088)	=	0.29/hr

   Total labor cost per manhour is then summarized as follows:

Labor and Direct Overhead	= $	9.58/hr
Indirect Overhead	=	3.80/hr
TOTAL	$	13.38/hr

2. Equipment Unit Costs

   "Blue Book" equipment rental rates which are "national averages" are available from:

   Dataquest, Inc.
   1220 Ridder Park Drive
   San Jose, CA 95131
   (408) 971-9000

This book allows you to see what equipment would cost if you must rent it. For in-house calculations, the following must be considered:

- replacement cost, say	$ 7.00/hr
- operating cost, say	10.00/hr
- maintenance cost, say	10.00/hr
TOTAL	$27.00/hr

3. Material Cost

Material cost may be obtained directly from a supplier. Typically, 8 inch PVC costs approximately $6.00/foot in 1988 dollars.

The key to condition analyses is good records. Figures 4.2 through 4.4 show recommended data recorded for maintenance histories. This data is most important in the evaluation portion of the CIP process. For those utilities willing and able to work with computers, there is an obvious advantage to computerizing the historical data.

FIGURE 4.2

COLLECTION SYSTEM MAINTENANCE REPORT

Work Order No._____ Condition:_____Emergency
Reported Date:_____ _____Planned
Repaired Date:_____

Exact Repair Location:_____

Component Repaired or Maintained:

_____Main _____Protruding Tap _____Service Saddle
_____Service Line _____Manhole

Description of Work:_____
_____
_____

Site Conditions: _____Soil type
_____Surface dimension of hole
_____Surfacing type

Main Condition: Pipe O.D._____
Pipe type_____
Depth cover_____
Backfilled with_____
Internal conditions_____
External conditions_____

ITEM DESCRIPTION	UNIT COST	HRS	EXTENSION
MATERIALS:			
EQUIPMENT:			
LABOR:			

FIGURE 4.3

SERVICE INVENTORY LOG

Street Number_____

Parcel Number (or account number)_____

Wye Location_____feet from_____

Date Installed_____

Pipe Type/Size_____

Repair History: Date (/ /) Description:_____

Date (/ /) Description:_____

Date (/ /) Description:_____

Date (/ /) Description:_____

Date (/ /) Description:_____

Date (/ /) Description:_____

Sketch:

FIGURE 4.4

CUSTOMER COMPLAINT LOG

Complaint No._____

Work Order No._____

Date_____

Time_____

Name_____

Address_____

Phone No._____

Type of Complaint_____
_____
_____

Action Taken_____
_____
_____

Date Resolved_____

Remarks (include any costs incurred to resolve such; may refer to work order)_____
_____
_____
_____
_____

COLLECTION SYSTEM EVALUATION

The following is a discussion of the considerations used on the Collection System Improvement (C.S.I.) form (Table 4.2). A discussion on how to use the rating forms for ranking projects is discussed under the section "Ranking of Mains". Upon development of repair and maintenance histories, the data is evaluated. Current annual maintenance and operating cost is compared to replacement costs, with operations and maintenance of the new system also considered.

The decision to continue repairs of a system segment or to replace it is primarily one of economics. It is relatively easy to assemble direct and indirect costs to operate, maintain, and repair existing systems if the data is assembled through figures 4.2, 4.3, and 4.4.

In addition to labor, equipment, material, and overhead costs, the following items must be considered:

* Costs for damage claims due to sewer backups, including insurance and legal costs.

* Cost for pumping and treatment of infiltrated groundwater or storm water inflow.

* Non-monetary factors such as health hazards imposed on residents from sewer backups, negative customer relations resulting from service disruption or environmental effects of raw sewage pollution of surface waters or private properties.

Non-Monetary Considerations

The effects of "hard to get" monetary costs for pumping and heating groundwater and storm water will not be further addressed in this handbook. Some of the above costs can be quantified by I/I analysis. For detailed evaluation methods of infiltration/inflow costs, readers should refer to one of the following:

1. Their consulting engineer

2. Gravity Sewer Design and Construction
   WPCF Manual of Practice - No. FD-5
   Publisher: Water Pollution Control Federation
   2626 Pennsylvania Avenue NW
   Washington, D.C. 20037

3. Design of Wastewater and Storm Water Pumping Stations
   WPCF Manual of Practice - No. FD-4

4. The Design and Operation of Small Sewage Works
   D. Barnes and F. Wilson
   Publisher: John F. Wiley and Sons
   New York, New York

5. Water Supply and Pollution Control
   Clark, Viessman, Hammer
   Publisher: Intex Educational Publishers
   666 Fifth Avenue
   New York, New York 10019

Damage claim costs, if any, are usually provided willingly by affected residents, insurance adjustors, or the plaintiff's lawyer. Keep records of these claims as the records will help the local government to analyze the nature of the problems.

If monetary values could be assigned to some of the risky nonmonetary factors discussed above, the cost of repairs might skyrocket and result in an easy decision favoring replacement. While it is not advisable to attempt to assign a cost to nonnmonetary considerations, they should definitely enter into the final decision making process.

Selection of Pipe Segments to Determine Repair or Replacement Priorities

The following section shows how to select pipe segments for evaluations on those pipe segments.

Selection of pipe segments: Choose pipe segments for inventory sections that have similar characteristics throughout their lengths. The following are examples of section boundary points that may be used:

* Roadway intersections
* Manholes
* Points where pipe is increased or decreased in size
* Changes in pipe type
* Significant changes in maintenance requirements, such as the start of a long section in an inaccessible easement.

Break-Even Analysis (Repair vs. Replace Decisions)

The "Break-Even" analysis determines when repairs or maintenance costs exceed replacement costs. An evaluation is made to determine when the extent of repairs and maintenance surpass the cost of replacement. The analysis is based upon comparison of direct labor, materials, equipment, operation, and overhead costs for existing conditions and new construction.

The economic trade-off between continued maintenance versus replacement compares the initial cost of replacement with the projected savings of future maintenance costs. The break-even rate may be defined as the point at which the cost of replacement for a given pipe segment equals the future cost savings of repair. If the occurrence of problems on a particular pipe section exceeds the break-even rate, it is economically advantageous to replace the main. Conversely, segments with less than the break-even rate may not be candidates for current replacement.

The break-even situation is presented as:

$$R = C$$

where:

R = annual worth of expected repair or maintenance savings.

C = cost of replacement, developed as an annual cost over the life of the project.

When R is greater than C, it costs more money to repair or maintain than to replace the pipe segment.

The annualized replacement cost is developed as follows:

C = 1.15 P (CRF)

where P = Present Worth of Construction Cost, developed from a local contractor's estimate, your engineer, State Water Quality Bureau staff, yourself, or a supplier.

1.15 P = Present worth of Project Cost, including 15% for legal, admin., and engineering

CRF = Capital Recovery Factor from Appendix D (Interest Table) for specific interest rate (i) and period (n). Choose interest equal to current annual bond rates, and period equal to term of debt (bond) retirement.

Annual worth of repair savings, R, is brought forward from the inventory sheets and includes all direct and indirect costs for labor, materials, equipment, damage claims, and all other costs associated with maintenance for the given year.

An example of collection system evaluation is shown as follows:

EXAMPLE (Break-Even Analysis)

From repair records, (Figure 4.2) for a given pipe segment, annual maintenance costs (R) are:

1. Root cutting, 800 L.F. of pipe @ $1.50 per foot = $1200

2. Chemical root control, 800 L.F. @ $1.00 per foot = $800

3. Hydraulic jetting, 800 L.F. @ $0.50 per foot = $400

4. Overtime pay for emergency sewer repairs: 12 crew hrs with jet @ $65.00 per hour = $780

5. Damage claim (from private party's insurance carrier) $3500

Total Annual Maintenance Cost, R = $6680.00

Additionally, TV records show 9 different locations with broken and cracked joints in the clay tile pipe.

From contractor preliminary quotes, Construction Cost P is estimated at $45.00 per foot, including restoration of graveled surfacing in the alley. Current bond interest rates are 10% for a 20 year bond.

P = $45.00/ft x 800 ft = $36,000.00
N = 20 years
i = 10 %
from Appendix D, the capital recovery factor (CRF) is .1175.

The annual amortized construction cost to repay this investment, C, is computed as follows:

C = 1.15 (P) (CRF)
C = 1.15 (36,000) (.11746)
C = $4736.00 per year

The ratio of R/C = $6680/$4736 = 1.41

In this unusually bad scenario, it is far more economical to replace the pipe segment rather than continue maintenance of the segment.

NOTE: Communities lacking repair cost histories should set up repair records. In the mean time, other evaluation methods shown later in this chapter will serve to set capital improvement priorities.

Service Reliability

In addition to strict monetary considerations for evaluation of the wastewater collection system, reliability of service is of key importance. In order to simplify the proposed rating procedure, point scores will be allotted for number of service blockages. These may be obtained from the customer complaint or work order cards.

Structural Integrity and Alignment

Another collection system characteristic that must be evaluated in developing replacement priorities is the structural integrity and alignment of the existing pipe segments. This information is available only from television surveys. If such information is unavailable, this structural integrity characteristic must be left out of the rating procedure. TV surveys reveal:

1. The existence of "swales" with negative grades or non flushing velocities.
2. Areas of concrete pipe with H_2S deterioration problems.
3. Protruding taps which preclude further televising, cleaning, and inspection.
4. Leaking joints (infiltration).
5. Cracked and broken pipe (usually clay tile).
6. Root problems.
7. "Tipped" pipe sections, usually in short (2 or 3 foot long) sections of old loose jointed clay tile or concrete. The tipped joints are the result of improper installation, loss of bedding material through pipe joints, infiltration, or a combination thereof.
8. Flattened PVC pipe sections.

In some cases with force mains, corroded cast iron pipe or galvanized mechanical joint bolts must also be evaluated. Consult your engineer in analyzing these problems.

Hydraulic Conditions (Water Movement, Pressure, and Capacity)

TV records, visual observation of manholes during peak flow periods, or installation of open channel flow meters reveal capacity problems with the collection system. Pipe segments are evaluated for capacity problems then rated in priority order.

Importance In Grid (Prioritization by Importance of Pipe Segment)

Interceptor sewers (those which carry flow from the collectors to the treatment facility) are more important than collectors. The collectors, which carry flow from the service laterals to the interceptors, are more important than the service laterals. For these reasons, each pipe segment is prioritized depending upon its relative importance to the system.

The following paragraphs explain how to set priorities using the previous data and economic analysis. Point scores are assigned based on the condition data and other criteria. Point scores are assigned for each pipe segment in order to set priorities.

Accessibility/Ease of Maintenance

Sewers in inaccessible easements, hampered by trees planted directly above the main and surface improvements blocking manhole access, are historically greater maintenance headaches than sewers in narrow alleys. Alternatively, sewers in narrow alleys are generally a bigger problem than those in highly accessible areas. In the evaluation and prioritization process for collection systems, accessibility, which has major maintenance cost ramifications, is considered in the ranking procedure.

ESTABLISHING COLLECTION SYSTEM PRIORITIES

Upon completion of economic analyses, priorities must be set. Utilities may use one of several approaches for rehabilitation planning. One approach is "management by crisis". It occurs only after large segments of the system have failed, and results in emergency repair contracts. This approach is unfortunately the most common, inefficient, and costly of the possibilities. A much better approach is the "Historical Data and Planning" approach. This approach helps utilities to prevent major problems and save money on repairs.

The Historical Data and Planning Approach to Wastewater Collection System Evaluation

The preceding historical data development and economic analysis is the most important component of the ranking procedure. See Figure 4.2 and 4.3. Only system segments which cause repeated repair problems should be analyzed. The previously referenced repair maps (with pins at problem locations) and the maintenance history data base are also necessary to further the process.

After completing the appropriate documentation, the forms are filed by street address and date in a central filing system (or on the computer). As part of the filing activity, update the wall map. During this step, system segments are chosen for economic analysis based upon the frequency of maintenance or repair activity.

Ranking of Mains

All wastewater collection system segments are then evaluated using TV records (if available), complaint forms, construction drawings, and operator knowledge for assignment of point scores in all rating areas.

The Wastewater Collection System Improvement form, Table 4.2, is used to assign point scores for system segments evaluated for improvements. A discussion of the point scoring system is as follows. Points are plugged into Table 4.3, by pipe segment, and segments are then ranked.

1. Economic Considerations: From the break-even analysis, compare annual maintenance costs (R) to replacement costs (C). If the ratio of R/C is greater than 1.0 for a particular pipe segment, then that pipe segment is assigned 10 points. If the ratio is 0.85, the segment is assigned 9 points, etc.

2. Service Reliability: System segments having 1 service outage per year (as manifested in a service callout, a pipe blockage, or a damage claim) are assigned 2 points. Points are increased with increased incidents of service outages.

3. Structural Integrity/Alignment: Television surveys are necessary to evaluate pipe segments under this rating category. It is not unusual, especially in areas containing groundwater, for old clay tile and concrete pipes to have very open joints. In groundwater situations or where ground movement is possible, the short 2 and 3 foot pipe sections are often misaligned or "tipped" resulting in uneven flow lines. There is also a need for frequent maintenance such as root killing and removal or jettings. If 90 to 100 percent of the joints are tipped or misaligned in a given segment, that pipe is assigned 10 points. Points are decreased with decreased incident of bad joints.

   Pipe segments are also evaluated based upon the extent of broken and cracked pipe as recorded in Table 4.3.

4. Hydraulic Conditions: Visual inspection in manholes during peak flow periods and after long periods of rain will identify sewer segments that are hydraulically overloaded. As discussed later in this chapter, the "extra" sewage may be the result of infiltration or inflow of ground or storm water, and must be addressed by your engineer. This rating element does highlight the need for further study, and places a high priority on finding the cause and solutions to these hydraulic overloads.

5. Importance In Grid: As shown on Figure 4.1, certain system segments are more important than others. Larger pipes in lower portions of the system are more important than those serving fewer people up stream.

6. Accessibility: Sewers that are located in inaccessible areas such as easements along the back property line of lots are more difficult and usually more expensive to repair. Conflicts with other utilities and conflicts with privately owned surface improvements usually make routine maintenance much more difficult. It is important that these system segments be kept in excellent working condition to prevent high legal liability problems and damage to adjacent private properties.

The Rating Procedures

Collection system segments are rated per Table 4.2, with point scores for all system segments totalled on Table 4.3. System segments may then be numerically ranked by point score (highest score first, etc.) to determine repair/improvement priorities.

Table 4.2

COLLECTION SYSTEM IMPROVEMENT FORM

	CONSIDERATION	Points
A.	**Break Even Analysis Results**	
1.	segments with R/C ratio greater than 1.0	10 pts.
2.	segments with R/C ratio from 0.8 to 1.0	9 pts.
3.	segments with R/C ratio from 0.6 to 0.8	7 pts.
4.	segments with R/C ratio from 0.4 to 0.6	5 pts.
5.	segments with R/C ratio from 0.2 to 0.4	3 pts.
6.	segments with R/C ratio from 0.0 to 0.2	1 pt.
B.	**Service Reliability**	
1.	1 service outage & blockage, or callout per year	2 pts.
2.	2 or 3 outages, etc. per year	5 pts.
3.	greater than 3 outages, etc. per year	8 pts.
C.	**Structural Integrity/Alignment**	
1.	tipped and misaligned joints, resulting in continuous infiltration of groundwater for	
	a. 90%-100% of the analyzed segment	10 pts.
	b. 70%-90% of the analyzed segment	8 pts.
	c. 40%-70% of the analyzed segment	6 pts.
	d. 10%-40% of the analyzed segment	3 pts.
	e. 0-10% of the analyzed segment	0 pts.
2.	cracked and broken pipe	
	a. 70%-100% of the analyzed segment	10 pts.
	b. 40%-70% of the analyzed segment	7 pts.
	c. 10%-40% of the analyzed segment	4 pts.
	d. 0-10% of the analyzed segment	1 pt.
3.	protruding taps preventing cleaning or televising (repair at wye or saddle only)	10 pts.
4.	pipe segments with H2S deterioration (for length of deteriorated pipe only)	10 pts.
5.	flexible pipe segments with deflections greater than manufacturer's recommendations	4 pts.
D.	**Hydraulic Conditions**	
1.	segments surcharged under peak load	10 pts.
2.	segments flowing 75%-100% full under peak load	7 pts.
3.	segments flowing under 75% full under peak load	0 pts.
4.	dry segments with services upstream	10 pts.

Table 4.2 (cont.)

E. Importance in Grid

1. interceptor sewers	3 pts.
2. collector sewers	1 pt.
3. service lines	0 pts.

F. Accessibility

1. in inaccessible easement	4 pts.
2. in narrow (20 foot or less) alley	2 pts.
3. in platted roadway	0 pts.

Table 4.3

Wastewater Collection System

Point Score Summary

PIPE SEGMENT	SCORES 1	2	3	4	5	6	7	TOTAL SCORE	NUMERICAL RANK
1. From____to____									
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									
11.									
12.									
13.									
14.									
15.									
16.									
17.									
18.									
19.									
20.									

Limitations To The Collection System Rating Procedure

One limitation to the rating procedure explained in this chapter is that Infiltration/Inflow (I/I) analysis is not included because it is too technical. The local government's engineer should perform I/I engineering on the sewer system. For EPA funded projects this is mandatory.

This analysis, performed by your engineer, determines if external sources of water infiltration (from groundwater or foundation drains) or inflow (from rainfall or runoff running directly into the system through manholes, interconnected storm sewers, or roof drains) are significant. If infiltration or inflow (I/I) is significant, your engineer may recommend replacement, storm sewer separation, or other measures. Oftentimes I/I causes hydraulic overloading of treatment systems which may cause violation of discharge permit regulations.

The rating procedure shown herein does not recognize the value of I/I analyses, which should be completed in communities that have unusually high and unexplained amounts of flow into their treatment system, or have high groundwater. The rating system may be modified by the community and their engineering consultant to include I/I.

Another limitation to the rating procedure is that it provides only rough estimates for financial and planning purposes. Talk to your engineer regarding cost estimates for anticipated repairs.

Finally, utilities are encouraged to have television surveys completed of their collection systems. This is fairly expensive, but is the best available method to check for interior corrosion from hydrogen sulfide, to find I/I problems, and to generally establish repair priorities. Fortunately, external corrosion is not a major problem in sanitary sewer systems.

ALTERNATIVES FOR SETTING WASTEWATER COLLECTION SYSTEM IMPROVEMENT PRIORITIES FOR UTILITIES THAT DO NOT HAVE HISTORICAL RECORDS ON SEWER MAIN BREAKS

The Problem of No Records of Sewer Main Breaks

As previously mentioned the historical data approach to setting priorities assumes that the utility has adequate records on sewer main breaks. But what if the utility has no records or very poor records of sewer main breaks? Many small towns and county water/sewer districts lack records on sewer main breaks. What if the mains are 70 years old and have not (yet) broken in large numbers, but the utility maintenance personnel suspect major breaks and problems in the near future? How does the utility set priorities for main repairs or replacements?

If no record of breaks exist, utilities need to set up a main break record keeping system for the future. In the meantime, there are other approaches you can use for setting priorities as alternatives to the historical data method.

Engineer's Inventory and Evaluation

In the absence of good historical records on repair activities the utility should strongly consider hiring an engineer. The engineer can help utility personnel and the governing body to clarify the current condition of the collection system and the apparent priorities for repair and replacement of sewer mains and other system components.

Comprehensive Master Plan Approach

A comprehensive engineering master plan is an accepted and common method that engineers use to identify system problems and recommend repair and replacement priorities. To prepare a comprehensive master plan a good engineering firm will conduct a variety of tests and evaluation on all parts of the system. Computer modeling, hydraulic tests, I/I analysis, and other sophisticated evaluations are conducted. Where possible, the master plan can also incorporate the historical data approach. For example, a slightly modified version of the point ranking system (Table 4.2) can be included in the master plan.

Financial Depreciation Table Approach

What if our town cannot afford the engineering master plan and has no records of main breaks? How can you set repair and replacement priorities? Another valid approach is to use a financial depreciation table to roughly estimate sewer main replacement needs. Accountants and engineers have developed rough estimates of how many years an "average" sewer main will last. This information has been converted into depreciation tables that accountants, engineers, finance officials, planners, and utility maintenance personnel can use to estimate when a utility's sewer mains need to be replaced. Apparently, less research has been done on depreciation of sewer mains than for water mains. According to the financial depreciation experts and the Commerce Clearinghouse Incorporated in Chicago, sewer mains are estimated to last 50 years. Any sewer mains that are over 50 years old may have to be replaced. Thus, you can estimate which sewer mains need to be replaced with this rough and simple method.

The use of a depreciation table must be combined with an inventory and inspection of the collection system by an engineer and the utility maintenance personnel. The lifespan of sewers is dependent on many factors such as soil types, water quality, hydraulics, and the susceptibility of the material from which the sewer main is made to corrosion. Thus the figure of 50 years may have to be modified based on an inspection of your collection system.

For details on depreciation tables see Chapter 6, "Raising The Money" and Appendix I.

Predictive Approach For Specific Sewer Mains

Another approach is called the predictive approach for specific sewer mains. This method uses a variety of tests to examine the corrosion processes at work on specific sewer main segments. Projections of the remaining useful life (if any) of the mains are made. Thus mains that should be replaced can be identified.

The predictive approach may require corrosion tests. Cutting small pieces ("coupons") from sewer mains to sample the degree of main deterioration may be necessary. Laboratory analysis may be necessary to determine how many years of service life the mains have left.

Unfortunately, the predictive approach requires scientific expertise that many small towns do not have available to them. Research is being conducted that may make the predictive approach more practical.

WASTEWATER PUMPING AND TREATMENT SYSTEM EVALUATION

This section will deal with inventory and record keeping procedures and provide an inventory of the evaluation and prioritization processes.

Regulatory Issues and Your Wastewater System

In 1972 Congress passed the Federal Clean Water Act. This Act has been further reinforced by Montana Administrative Rules, which are enforced by the Montana Department of Health and Environmental Sciences. Current regulations primarily set effluent standards from wastewater treatment plants, and set standards of quality in receiving streams. Regulations may change in the near future. For further information on regulations and how they affect necessary repairs and improvements to your wastewater system contact the Montana Department of Health, Water Quality Bureau (444-2406).

Wastewater Treatment Evaluation - Engineer Needed

Wastewater treatment evaluation and pumping system evaluations are very technical subjects and as such cannot be simplified to layman terminology. The wastewater treatment industry is a constantly changing phenomenon and is difficult to keep up to date. For these reasons, it is recommended that actual evaluation of pumping and treatment processes be left to the community's engineer.

Utilities can best aid their professional engineers by keeping detailed operations and maintenance records from which evaluation can be made. Adequate inventory and record keeping saves design dollars, assures a better quality design, and eliminates "guesswork" and assumptions on the part of the engineer. The operating records are also of obvious value to the treatment plant manager from an operational and efficient standpoint. The records will show variations in operating trends that may be of concern. For example, periodic "wire to water" pump efficiency curve tests allows the utilities to gauge the need for pump rehabilitation or replacement.

Inventory and Evaluation, Pump Systems (Pump Tests)

Pump curves should be obtained for all new installations. New head versus discharge curves should be developed on a periodic basis to check for efficiency changes. See Appendix G for pump curve development information.

Similar to the work orders shown in the Wastewater Collection section of this chapter, pump servicing should be documented as shown in Figure 4.5.

Wire to water tests as explained in Appendix H should be done annually to calculate pump efficiency. Annual repair costs should be logged (including equipment, labor, and materials costs as discussed under water distribution), and an annual pump operating cost developed. When the annual cost of operating and current pump (including electricity) exceeds the annualized cost of a new, more efficient unit the replacement should be made. See Appendix H for wire to water pump efficiency and pumping cost calculations.

Prioritization of this capital expense must be addressed by common sense methods. Is the pump part of a multi-pump station? Will the station pumping capacity meet demands if the pump is taken off line for extensive repairs? Are other system improvements, such as main replacement, more critical due to their higher monetary repair costs? These questions must be answered individually.

The pump stations should also be evaluated for age, condition, and reliability of pump control systems. This is best done by your engineer.

Inventory and Evaluation, Treatment Systems

As discussed previously, plant evaluation is a very technical subject. A brief overview as to what goes into a plant evaluation is now provided for the information of the reader only. The community's engineer should perform the following process control evaluations.

Typical plant evaluations include:

1. What is the quality (Total Suspended Solids), and biochemical oxygen demand (BOD) of the incoming wastewater?

2. Is the quantity of wastewater normal for a community of this size?

3. What is the projected wastewater flow in future years? Is the current facility capable to meet those demands?

4. Are current effluent standards being met? If not, why?

Plant and pump station equipment, including chemical feed pumps and motors, valves, compressors, and control systems should be monitored for repair costs. As shown in Figure 4.5, each equipment item should have a card with repair histories and costs. During annual budget review, all direct and indirect costs associated with repairs should be evaluated against equipment replacement costs. If historical repair costs exceed replacement costs, the piece of equipment should be replaced. The utilities must judge the relative importance of each system segment and assign a replacement priority for it.

With excellent operating records, the community's engineer may make much better decisions with less guess work for a lower cost, and produce a better quality design.

Temporary Options For Setting Wastewater Treatment Improvement Priorities For Utilities Which Lack Sufficient Funds To Hire An Engineer

If the community is currently unable to pay for an engineer's evaluation of wastewater treatment, what alternatives exist to roughly estimate treatment needs? First of all, the community should make every conceivable effort to obtain professional engineering assistance. Raising local user fees or taxes in order to obtain the funds for engineering must be seriously considered. In addition, local officials should contact state and federal wastewater system funding agencies for assistance. Some of these agencies may provide loans for preliminary engineering. The State Revolving Loan Program (SRF) has partial grants for engineering available for needy communities. Call the SRF Staff at 444-2406 for details.

Secondly, the local officials should contact the Montana Department of Health, Water Quality Bureau (WQB) at 444-2406. The WQB may have data, inspection reports, and other information on your treatment system. They may be able to provide general information on the nature of the improvements needed.

One last option is the use of a depreciation table. Depreciation tables have been developed by engineers and accountants which roughly estimate the useful life of treatment plants. The use of a depreciation table is not a precise engineering analysis. Instead it is a rough financial planning tool. See Chapter 6 and Appendix I for details on depreciation tables. The use of a depreciation table is not a substitute for an engineer's inspection of your of your system.

At some point the utility will be legally required to hire an engineer if major improvements to wastewater treatment are necessary. State and federal laws require the hiring of engineers under certain circumstances. For further information contact the WQB at 444-2406.

FIGURE 4.5

SAMPLE EQUIPMENT INFORMATION CARD

Equipment_____

Location_____

Equipment No._____Serial No._____

ELECTRICAL OR MECHANICAL INFORMATION:

Model_____ Size_____ Type_____

Voltage_____ Amps_____ RPM_____

Capacity_____ _____ _____

Original Installation Date_____

Supplier Information_____

_____

_____

SERVICE DATE	REMARKS	SERVICE DATE	REMARKS

SUMMARY

In summary, all elements of the wastewater system should be evaluated and prioritized on an annual basis for inclusion in an ongoing 5 year capital improvements plan. Attached on Table 4.7 is a summary checklist of items analyzed for possible inclusion in the list of wastewater improvements priorities.

First, a solid data base must be developed to monitor and summarize O & M costs in all areas.

Second, the data is evaluated for ranking of individual projects in priority order.

As shown in Chapter 5, wastewater projects must then be evaluated and fitted into the larger Mini CIP.

Finally, the list or matrix of needed wastewater improvement priorities should be typed in draft form. Table 4.5 is an example of a draft wastewater CIP.

TABLE 4.4

WASTEWATER SYSTEM EVALUATION CHECKLIST

1. ____ collection system repairs
2. ____ service laterial repairs
3. ____ manhole repairs (including I/I correction)
4. ____ pump station equipment (controls, pumps, motors, piping, valving, safety equipment)
5. ____ safety equipment
6. ____ vehicles and rolling stock (including cleaning, root cutting, etc.)
7. ____ treatment equipment (electrical, mechanical, process controls, metering, pumping, record keeping, etc.)
8. ____ laboratory equipment supplies, services
9. ____ office and administrative items (billing, software packages, etc.)
10. ____ miscellaneous hand and power tools
11. ____ grounds keeping equipment
12. ____ specialized services (televising cleaning, root killing, master plans, plant evaluations, etc.)
13. ____ upgrades for regulatory changes (lab and reporting requirements, Clean Water Act compliance, DHS requirements, etc.)

TABLE 4.5

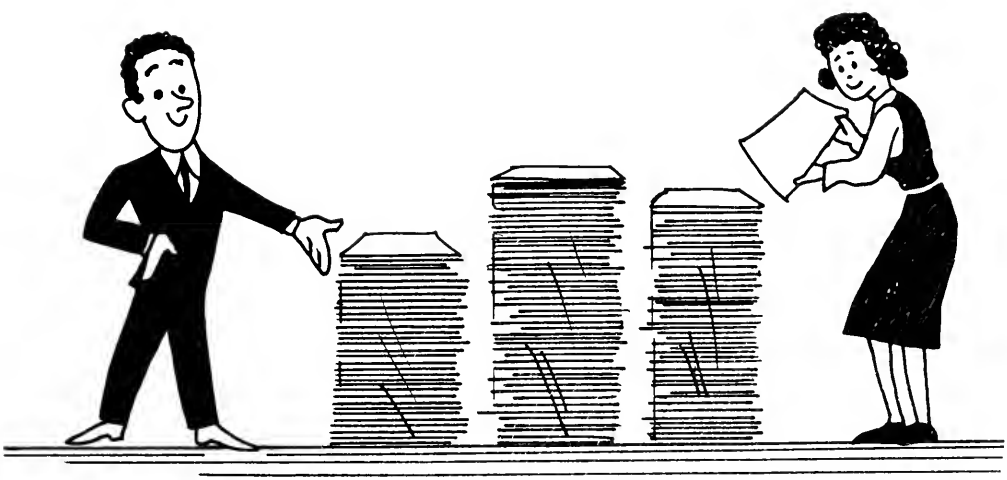
EXAMPLE OF WASTEWATER SYSTEM IMPROVEMENTS PRIORITIES

MAY 1988

	FY 88	FY 89	FY 90	FY 91	FY 92
I. SEWER MAIN CONSTRUCTION					
A. Southside Sewer (rehab.)		$450,000			
B. North Sewer Interceptor		$807,000			
II. PLANT MODIFICATIONS					
A. Conduct Comprehensive Performance Evaluation (MT Dept. of Health, Water Quality Bureau)	No Charge				
III. LIFT STATIONS					
A. Montana St. Lift Station (scheduled repairs)					$10,000
IV. SPECIAL PROJECTS					
None					
TOTALS		$1,257,000			$10,000

CHAPTER FIVE

PUTTING IT ALL TOGETHER



OVERVIEW OF CHAPTER

Upon completion of inventories, data gathering, cost estimates, evaluation and ranking of replacement needs for each public works facility (street,water, and wastewater), an overall plan must be developed for an integrated public works CIP. Upon completion of individual rankings for water, wastewater, and streets, prioritized lists showing project locations and costs will be developed. Examples of such lists are shown on Tables 5.1, 5.2, and 5.3.

Potential funding sources may also be identified, but can rarely be guaranteed pending the political outcome of the budgeting process, public opinion, grant availability, and user rate increases.

These individual lists must be combined into an integrated public works package to assure:

1. minimal public disruption during the construction process
2. maximum efficiency of the construction process (Example: combining water main and street replacement in one project to save money and time).
3. orderly, coherent project development
4. positive public relations

To integrate this information, maps and visual aids are very helpful. The following step by step method should be used to integrate the data previously collected. Table 5.4 is the integrated (draft) Mini CIP.

INTEGRATION PROCESS

1. As per previous chapters, bring forward prioritized improvement lists for streets, sewer, and water. See Table 5.1 for sample water priorities list, Table 5.2 for sewer priorities list, Table 5.3 for street priorities list.
2. Using colored pencils, mark up a community map showing location and year of each proposed improvement on all lists. (Blue for water, green for sewer, red for street.)
3. Check for schedule conflicts. Do not, for example, pave a street in 1990 and dig it up to install a water main in 1991.
4. Reprioritize and coordinate the overall program. Develop a draft five-year CIP summary as shown in Table 5.4.
5. Seek governing body support and public support for the draft program through their review. Explain the needs. Explain the consequences if nothing is done.
6. Set final priorities.
7. Seek funding. (Propose fee increases, apply for grants, etc.)

The end result is a comprehensive replacement schedule (draft Mini CIP). This schedule is a goal, and is subject to funding availabilities. It is most important to complete the process first before seeking funds in order to have solid documentation of needs.

Remember, the draft Mini CIP should be completed before the governing body sets the

annual budget. The governing body needs to decide which projects on the Mini CIP are to be paid for with local funds.

Chapter 6 deals with funding of projects, and Chapter 7 with public education efforts related to explaining the CIP process. These last two steps are the most important of the entire process, and run concurrently.

Keep in mind that the Mini CIP deals with wastewater, water, and streets, but the format may be transferred to parks, recreation facilities, traffic control, buildings (especially in terms of energy conservation), vehicle maintenance/replacement, and other types of public facilities.

SUGGESTED MINI CIP CALENDAR

FIRST YEAR

1.	INITIATE PROGRAM	AUGUST
2.	INVENTORY FACILITIES	SEPTEMBER - NOVEMBER
3.	DETERMINE STATUS OF PREVIOUSLY APPROVED PROJECTS	OCTOBER
4.	EVALUATIONS (needs and finance options)	OCTOBER -JANUARY
5.	SET PRELIMINARY PRIORITIES	JANUARY
6.	PUTTING IT ALL TOGETHER	FEBRUARY
7.	PUBLIC PARTICIPATION	MARCH - MAY
8.	ADOPT C.I.P.	MAY
9.	ADOPT BUDGET	JULY
10.	CONSTRUCTION IMPROVEMENTS	APRIL - OCTOBER

EACH FOLLOWING YEAR

1.	REVIEW/REVISE CIP	FEBRUARY - MAY
2.	REPEAT STEPS 2-10 (FROM FIRST YEAR) AS APPROPRIATE	

NONTECHNICAL CONSIDERATIONS

Listed below are suggested criteria against which each proposed infrastructure project can be judged. Using this proposed system of evaluation, each project request should be accompanied by the types of information noted below. This is not to say that all such information is to be included in the Mini CIP. Rather, this information is to be used only to help rank each project in order of priority.

Suggested Criteria For Setting Priorities

1. Financial Impacts

   a. Capital Costs

      The governing body should be provided with information concerning both the portion of the project costs for which the local government itself is responsible and the portion which will be paid by others. If expenditures will be incurred over a period of more than one year, all long-term costs should be shown.

      When computing the cost of a capital project or a capital acquisition in the Capital Improvement Plan it is essential to include all expenses reasonably related to that project. For example, if a property is to be purchased for the purpose of building an above ground water storage reservoir, show all sources of funding (including that provided by others). If a project includes treatment plant expansion, costs should include site appraisal, title search, purchase, and closing costs for additional purchases. Show cost savings obtainable from installation of the improvement.

   b. Reducing Operating and Maintenance (O & M) Costs

      One of the major reasons for capital projects is often to reduce O & M costs. It is important not to underestimate the degree to which O & M costs affect your operating budget. Several studies have shown that for typical public facilities, such as street lighting or water main improvements, O & M costs over the useful life of the facilities are likely to exceed their initial cost of installation. Therefore, any capital improvements which can reduce operating costs should be seriously considered. For example, a water main replacement project may offer considerable savings over the continuing O & M costs of repairing an antiquated system. On the other hand, the construction of a new municipal parking lot will almost certainly increase O & M costs for your community. Once construction is completed, your local government will be called upon to provide a whole range of services including mechanical sweeping, snow plowing, landscaping, pavement resurfacing, daily checking of parking meters, etc. By clearly stating the added long-term O & M costs arising from an expansion of your facilities, your local government can accurately anticipate future increases in its annual operating budget.

   c. Changes in Local Government Revenue

      Some proposed infrastructure projects will positively or negatively affect your jurisdiction's tax revenues or service charges. For example, a roadway extension constructed to serve a proposed manufacturing plant will help generate increased local property tax income. Similarly, a sanitary sewer extension project will generate additional hook-on fees and monthly user charges. These revenue changes should all be calculated.

2. Health and Safety Effects

Many public works projects will have an important impact on the crucial area of public safety. These impacts may be indirect (as when a water treatment plant project improves the taste of drinking water), or direct (as when a road widening and signalization project reduces deaths and injuries). While it is difficult to assign a dollar value, they represent perhaps the most valuable public service which any government can provide and should be documented to the community. The value of the project in lives saved or injuries prevented should be stated in your Mini CIP. Make sure you communicate these benefits of the project to the governing body, media, and citizens. Projects which protect public health and safety should have a very high priority.

3. Effects on Local Economic Development

Economic development means business expansion and creation of new jobs. Since economic development is the objective of many capital projects, it is important to set forth to your local elected officials, business leaders and civic groups the close correlation between capital improvements and economic development. For example, the economic benefits of a project should be documented in the following areas:

* Local property tax base
* Property values
* Increased employment
* Investment in local economy
* Stabilization or rehabilitation of declining neighborhoods

4. Civic Pride and Community Livability

Falling under this category are all capital improvement impacts which would affect the environmental, aesthetic or social condition of your community. Examples include the reduction of traffic congestion, air pollution, and noise in a downtown shopping area.

5. Public Support

It is usually desirable to place a higher priority on projects which have generated a good deal of public support. If you have undertaken a citizen survey (by telephone, mail, or in person) or a public hearing concerning your capital improvement program, it will be easier for you to gauge public support.

It should be remembered that without a sufficient degree of public support, some public projects (such as those backed by general obligation bonds or special assessments) simply cannot go forward due to statutory requirements for public approval. Therefore, your local government should treat the matter of public support not only as a desirable justification, but as a pre-requisite for many public works projects. See Chapter 7 for further discussion of this very important topic.

6. Compliance With State or Federal Regulations

A high priority should be assigned to projects which are required by state or federal regulations. Failure to comply with regulations could result in threats to public health or safety, damage to the environment, and fines levied against your local government.

7. Availability Of Funds

If funding is available "right now" for one project, you probably will want to assign this project a higher priority ranking. Projects for which funding is not available or difficult projects to finance are normally assigned lower priorities.

ETTING PRIORITIES: STREETS PROJECTS VS. WASTEWATER PROJECTS VS. WATER PROJECTS

Setting priorities between types of facilities is another task for the governing body and staff. The typical situation is that there is not enough money to do everything. For any single year the governing body may have to choose between fixing the water treatment plant versus replacing Main street. There are no easy answers, although the 7 criteria previously mentioned can help clarify the priorities. Because the CIP looks forward 5 years, projects that cannot be financed this year could be scheduled for financing in year 2, 3, 4 or 5.

Project Summaries

Table 5.4 indicates that more detailed information is available for description of priority projects. This information is very helpful in dealing with the governing body, the press, and the public. A summary of each project should be attached to the overall priority list, Table 5.4.

The summary sheets should contain as a model format:

1. Name of Project
2. Anticipated Construction Date
3. Location of Project
4. Description of Project
5. Condition of Existing System
6. Land Acquisition/Easements Required
7. Adherence to Comprehensive Plan
8. Anticipated Benefits (Why Needed)
9. Anticipated Construction Cost
10. Annual Operation and Maintenance Costs
11. Project Funding Sources
12. Anticipated Tax and Economic Effects of the Project
13. Public Support for the Project
14. Estimated Life Expectancy of the Project
15. Date of Project Summary Update

The list above may be amended to suit your own local needs. You may find that a more simplified version of the Project Summary would be more easily prepared and reviewed by your local officials and still serve to provide the most important information on each project.

Additional Suggestions On Setting Priorities

The following points are offered as an outline for a successful priority setting process.

* *Consistently maintain financial viability through financial planning.*
* *Assure availability of qualified technical expertise.*
* *Promote technological innovation, "fresh ideas"; avoid quick "cookbook" approaches.*
* *Determine public <u>needs</u> for service as well as "wishes" in changing economic environment.*
* *Communicate these needs to the customer, and the costs of facilities to meet those needs. Encourage public participation.*
* *Involve the regulatory or granting agency in the decision-making process to assure full understanding of the project by all parties.*
* *Employ the planning process continuously (annually) for updates.*
* *Do not be afraid to plan for things you cannot currently afford; be realistic in your needs and work to obtain required funds.*

The Draft Mini CIP

Table 5.4 shows your <u>preliminary</u> Mini CIP. For convenience you may want to put the summary sheet, project summaries, water/wastewater/street matrices, and other information in a 3-ring binder. Or you may want to staple it together so you can make multiple copies for distribution to the public.

The next step is to involve the public. The draft Mini CIP needs to be explained to the citizens and media. Public input, criticism, and suggestions need to be sought. Chapter 7 explains how to involve the public.

TABLE 5.1

EXAMPLE OF WATER SYSTEM IMPROVEMENT PRIORITIES

MAY 1988

	FY 88	FY 89	FY 90	FY 91	FY 92
I. CONSERVATION					
A. Meters	$ 37,000	$ 37,000	$ 20,000	$ 20,000	0
B. Tapping Saddle Replacement	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000
II. WATER MAIN RECONSTRUCTION					
A. Replacement -					
Main Street	$400,000				
Maple Street				$ 70,000	
2nd, 5th Avenue				$ 80,000	
B. Extension -					
Westside					$ 77,000
III. PLANT MODIFICATIONS					
A. Clarifier Rehab.		$ 37,000			
B. Energy Conser. Improvements		$ 40,000			
C. Chemical Storage Rehab.		$ 17,000			
IV. BOOSTER STATIONS/TANKS					
A. East Booster Tank Repair			$ 75,000		
B. Telemetry Changeout			$ 15,000		
C. 33rd Street Transformer			$ 9,000		
V. SPECIAL PROJECTS					
A. Hydrant Changeout					$ 17,000
B. Highway/Utility Conflicts					$ 10,000
TOTALS	$442,000	$136,000	$124,000	$175,000	$109,000

EXAMPLE OF WASTEWATER SYSTEM IMPROVEMENT PRIORITIES

MAY 1988

	FY 88	FY 89	FY 90	FY 91	FY 92
I. SEWER MAIN CONSTRUCTION					
A. Southside Sewer (Rehab.)		$450,000			
B. North Sewer Interceptor		$807,000			
II. PLANT MODIFICATIONS					
A. Conduct Comprehensive Performance Evaluation (MT Dept. of Health, Water Quality Bureau)	No Charge				
III. LIFT STATIONS					
A. Montana St. Lift Station (scheduled repairs)					$ 10,000
IV. SPECIAL PROJECTS					
None					
TOTALS		$1,257,000			$10,000

TABLE 5.3

EXAMPLE OF STREET SYSTEM IMPROVEMENT PRIORITIES

MAY 1988

PRIORITY	STREET	FROM	TO	SURFACE TYPE	SCI*	WORK NEEDED	FY 88	FY 89	FY 90	FY 91	FY 92
1	Lark	Thurman	Lane	Paved	60	Overlay	$ 38,100		Maint.		
2	Washington	Porter	Lewis	Paved	66	Slurry Seal			Maint.	$ 2,700	
3	Clinton	Helena	Kalispell	Paved	69	Slurry Seal			Maint.		$ 2,000
4	Clark	Lane	City Lim.	Unsurfaced	71	Maint.	Maint.			Maint.	
5	Dudley	Montana	Kalispell	Unsurfaced	72	Maint.	Maint.			Maint.	
6	King	Helena	Kalispell	Unsurfaced	72	Maint.	Maint.			Maint.	
7	Prickly Pear	Porter	Lewis	Unsurfaced	74	Maint.	Maint.				
8	Grand	Porter	Lewis	Unsurfaced	78	Maint.	Maint.				
9	Lark	Lane	Casey	Unsurfaced	78	Maint.	Maint.				
10	Riggs	Montana	Kalispell	Unsurfaced	79	Maint.	Maint.				
11	Groschell	Harrison	Kalispell	Unsurfaced	83	No Action					Maint.
12	Thurman	Clinton	Groschell	Unsurfaced	83	No Action					Maint.
13	Lewis	Montana	Washington	Paved	86	No Action					Maint.
14	Kalispell	Main	Lewis	Unsurfaced	89	No Action					Maint.
15	Lark	Montana	Creek	Paved	90	No Action					Maint.

* SCI - Street Condition Index Number (The lower the number, the worse the condition of the street)

Maint. - Normal maintenance by City Staff

EXAMPLE OF A MINI CAPITAL IMPROVEMENTS PLAN: FY 1988-1993

OVERALL PRIORITY RANKING	CONSTRUCTION DATE	PROJECT NAME	PROJECT COST	FUNDING PARTICIPATION	FUNDING SOURCES
1	FY 88	Lark Street Improvement Project	$ 38,100	$ 25,000	EDA
				$ 13,100	Gas Tax
2	FY 89	Southside Sewer (Rehab)	$450,000	$450,000	Sewer Bond
3	FY 89	North Sewer Interceptor (Replace)	$807,000	$443,850 $363,150	EPA Sewer Reserves
4	FY 90	Washington Street Slurry Seal	$ 2,700	$ 2,700	General Fund
5	FY 91	Maple Street Water Main Replacement	$ 70,000	$ 10,000 $ 60,000	Water Reserves FmHA Loan
6	FY 91	2nd & 5th Avenues Main Replacement	$135,000	$ 80,000 $ 55,000	Water Reserves DNRC
7	FY 92	High School Area Hydrant Replacement	$ 25,000	$ 25,000	Hydrant Maintenance District
8	FY 92	Clinton St. Slurry Seal Project	$ 2,000	$ 2,000	Gas Tax
9	FY 92	Water Main Extension Westside	$ 77,000	$ 77,000	Bond
10	FY 92	Montana St. Lift Station (Repairs)	$ 10,000	$ 10,000	User Fee

CHAPTER SIX

RAISING THE MONEY

OVERVIEW OF CHAPTER

It is important to remember that the Five-Year Capital Improvement Plan is a planning tool to assist local officials in identifying, prioritizing, and scheduling various public works projects over the coming years. Without the actual budgeting and appropriation of funds for each successive year, the Capital Improvement Plan is destined to fade into obscurity as a well-intended, but under-utilized process and document. This chapter outlines the critical process of annual capital improvement budgeting and financing.

It must be remembered that the CIP is a document which prioritizes needs, and funds may not necessarily exist to fund all elements of the plan. While local government is encouraged to be realistic in developing and updating of a CIP, needed projects should not be withheld from the list due to the apparent lack of funds. In the future, funds may become available from outside sources or citizen willingness to pay for the projects may change.

FINANCIAL ANALYSIS -- WHO DOES WHAT?

Roles and Responsibilities

Financing public facility improvements is a continual and sometimes complex process. Typically, for an individual local government, several local officials, staff, and consultants will be involved. Each of these persons will have a different role in the financing process. Although the responsibilities of each person may vary from one local government to another, the following overview shows who is typically involved and what role they play.

* Role of the governing body - By Montana Law, the governing body makes the final decisions (except for general obligation bond issues which require a direct vote of the people). For municipalities, the Mayor (the executive) will usually prepare the financial options in conjunction with his staff. The council members (the policy makers) will make the final financial decisions.

  For county water and sewer districts, one of the board members should be assigned the job of preparing the options, in consultation with any district staff or consultants. The full board makes the final decisions.

* Role of Lead Financial Researcher (CIP Coordinator) - Someone should assume the role of lead person for researching and analyzing various financial options. The researcher, working under the guidance of the governing body, should identify financing alternatives and the advantages and disadvantages of each option. This individual may also have the responsibility of preparing and coordinating the CIP. For municipal governments, this person is usually the city clerk. Sometimes the city planning director assumes this job, if the community has a planning director. The lead researcher may be a board member or a consulting engineer.

* Role of Public Works Director or Maintenance Supervisor - The role of the public works director or maintenance supervisor is to manage and maintain the public facilities on a daily basis and to participate in the assessment of improvement needs. In terms of financing, the director not have a prescribed role. However, there are several reasons why the director should be involved. Many directors have practical ideas to reduce improvement costs. They may have information on innovations being used by other communities. In addition, the director will have information on calculating the cost of planned improvements.

* Role of Engineer - Although certain parts of the street, sewer, and water needs assessment may be done by the non-engineer, it is critical that an engineer review

the needs assessment and that the engineer conduct the assessment of needs for water and wastewater treatment facilities. As discussed in the needs assessment chapters, it is desirable that an engineer prepare a master plan for water and wastewater facilities. By state law, certain major water and wastewater system improvements must be designed by a registered engineer. Montana law does not prescribe a financial role for engineers, nor does the law forbid it. Many engineering firms offer financial services to their clients -- services such as grant writing, rate studies, financial option analysis, etc. If your local government intends to have an engineer provide financial services, it is important that you select a firm with a proven track record in getting improvements financed.

* Role of Local Government Attorney - Many financing proposals involve legal questions and interpretations. The local government's attorney should be involved early in the process to resolve any legal questions. Some types of financing require public notice and public hearings. An attorney should be involved to make sure that all procedures used by the government comply with applicable laws. If a Public Service Commission hearing is necessary, an attorney will need to prepare the case. County water/sewer districts are not legally required to have an attorney, however, it is suggested that they retain one on an "as needed" basis.

* Role of Private Bond Counsel - If bonds are proposed as a financing alternative, contact private bond counsel early in the process. You should interview two or three firms before selecting your counsel. By getting a bond counsel involved early, you can avoid many pitfalls. The counsel will help you to determine the proper amount of the issue, help with establishing repayment schedules and provide guidance on related matters, thus, saving the local government time and money.

Team Approach To Preparing The Mini CIP

Given the number of individuals involved, each of whom has a different role and perspective, it is important to provide coordination. A team approach, using a small committee, is one way to achieve coordination. The CIP coordinator should make sure everyone knows their job and that the work gets done. Regular meetings of the committee should be scheduled. The committee must have the draft Mini CIP ready for governing body action before the annual budget is prepared.

STEPS IN THE FINANCING PROCESS

It would be impossible to give a single detailed method for the financial process given the variety of financial options, differences in individual governments, etc. However, it is possible to list the basic steps in financial analysis and decision making.

In a nutshell, the financing process boils down to the following steps:

1. *Determine needs for each facility - streets, roads, water, sewer.*

2. *Set priorities for repairs and improvements within each facility and between different types of facilities.*

3. *Seek general public input on needs (i.e. public meetings, civic club presentations, citizen questionnaire).*

4. *Study your government's existing financial condition and capacity to pay for the needs.*

5. *Prepare a simple financial forecast (i.e. how much tax and user fee revenue the government expects for the next 5 years).*

6. *Research and analyze alternative ways to pay for the needs (this may include a rate study).*

7. *Determine the preferred financing for each project.*

8. *Seek public input (i.e. public meetings, press coverage, budget hearing).*

9. *Adopt annual budget based on preferred financial plan.*

10. *Carry out financing (i.e. apply for grant, propose rate increase, spend street/road funds, create special improvement district, etc.).*

11. *Troubleshoot (i.e. grants may be denied, rate increases may be rejected, improvement districts may be voted down).*

12. *Update Mini CIP each year prior to setting annual budget. (If all projects are completed, analyze needs for new repairs due to system deterioration and add a new year to the CIP to keep it a 5-year plan).*

PREPARING A SIMPLE FINANCIAL FORECAST

At this point in the financing process, you should develop a financial forecast of the public funds which are likely to be available for financing improvements over the coming five years. Without such a forecast, it will be impossible to estimate how many projects to schedule in each budget year of the five year plan. It will also be impossible to project how much money may be necessary from outside funding sources. Generally, a water or sewer rate study is required to estimate financial impacts for large scale water or sewer projects.

Who is to Prepare the Financial Forecast?

The individual who is most acquainted with your local finances is probably most suited to undertake your financial forecast. In most cases, this individual will be your administrator, manager, engineer, budget officer, finance director, clerk, or treasurer. Using available information concerning historical revenue and expenditure trends, this individual can develop a forecast of revenues from all available sources to be dedicated toward funding of the Mini CIP.

Doing a Revenue Forecast

The number of capital improvement projects that a local government can finance will depend on two factors. The first of these involves the capacity of the local government to bear general obligation bond indebtedness to fund future projects. Bonding capacity, in turn, will depend on the amount of general obligation debt that has been previously issued, as well as on the statutory limits on public indebtedness which apply to that local government. If your municipality has not reached its statutory debt ceiling and if you feel that your community is likely to support additional debt issues, your revenue forecast should reflect additional bond issuance as a potential revenue source. Keep in mind that there are no statutory limitations on the amount of revenue bonds which can be issued. (Note: Bond

limits only apply to municipal governments, not to county water/sewer districts).

The second factor in forecasting revenues is the availability of funds from sources other than debt issuance. These sources may include the utilization of current cash balances, property taxes, user fees, motor fuel taxes, developer impact donations, etc. Ideally, a portion of these revenues should be placed in special accounts which are earmarked for the financing of capital improvements.

The final product of the revenue forecast is a reasonably reliable estimate of all revenues likely to be available over the next five years for capital projects, and for general operating expenses improvement.

Doing an Expenditure Forecast

In developing your expenditure forecast, it is desirable to obtain information concerning historical trends in three years of expenditures: normal operating expenses, capital improvement expenses, and debt service expenses. It is possible to estimate future expenditures by calculating the average expenditure increase experienced in past years. This estimating procedure must take into account, however, unusual fluctuations which are anticipated in the rate of inflation, or in the level of operating, capital improvement or debt service expenditures.

Calculating the Availability of Future Capital Project Funding

Upon completing the forecasts of revenues and expenditures, one is in a position to compute the amount of funding likely to be available to finance new capital projects over the next five years. The formula for making this simple computation may be stated as follows:

	Projected Revenues
(Minus)	Projected Operating Expenses
(Minus)	Projected Debt Service
(Equals)	Funding Available for Capital Projects

Thus, with your financial forecast in hand you are now ready to research other sources of funds.

SPECIAL CONSIDERATIONS FOR FINANCING WATER AND SEWER IMPROVEMENTS

Detailed Department of Commerce Financing Handbook Available

The Department of Commerce publishes a comprehensive book about financing sewer and water systems titled: Planning and Financing Community Water and Sewer Systems in Montana. The book is written in non-technical layperson language for local government officials and staff. It is recommended that you obtain a copy, as the information in the book will not be repeated here. Free copies have already been made available to all Montana municipalities, counties, and water/sewer districts. (Contact: Montana Department of Commerce, Community Technical Assistance Program, 444-3757).

State Utility Laws for Municipalities

Section 69-7-101 through 69-7-201 of Montana Code Annotated (MCA) governs municipal utility rates in Montana. Municipal officials and staff should thoroughly review this law with the help of their attorney. The law gives a municipality the power to regulate, as it considers proper and prudent, all rates, charges, and service classifications. Rates, charges,

and classifications must be "reasonable and just". They cannot be increased more than 12 percent per year except to finance "mandated improvements" or unless approved by the State Public Service Commission. This legal citation requires municipalities to publish public notice and to hold public hearings when rate increases are proposed.

Section 7-6-4134, MCA limits a municipal government's power to finance major capital improvements from a special reserve account. Only 5% of a municipal governments annual all purpose mill levy can be placed in a capital improvements fund to make improvements to water, wastewater, and other public facilities. This restriction makes it very difficult to pay for ongoing system improvements out of reserve monies.

Neither of these two laws apply to county water/sewer districts -- only to municipalities. County water/sewer districts are free to set rates without PSC regulation and to use reserve funds to pay for major improvements.

Public Service Commission

The Public Service Commission (PSC) is a state government body which oversees and regulates utility rates, including municipal water and sewer rates and utility management practices. (See 69-2-101 through 69-3-405, MCA). In terms of water and sewer facilities, the PSC only regulates municipalities, not county water and sewer districts.

It is important that municipal officials budget adequate time and money for preparation of PSC testimony. If the rate proposal meets with significant public controversy, the project may be delayed, denied, or changed in scope. This requires more time to be invested by local officials. Delays or changes in the project due to PSC actions will also affect the availability or timing of any pending grants or loan commitments the municipality may have. Legal, financial, and engineering information will have to be prepared -- possibly requiring more local government money to be spent.

Local officials will have to prove to the PSC that the rate increase is reasonable and that the project is needed. Having solid facts, such as a Mini CIP with a simple cost/benefit analysis, will make the process smoother for all parties. To help municipalities with this process the Community Technical Assistance Program (CTAP) of the Montana Department of Commerce has published, A Short Guide to the Public Service Commission's Review of Municipal Water or Sewer Rate Increase Proposals. Copies of this publication are available from CTAP by calling 444-3757.

Setting Water and Sewer Rates

Revenue bonds (often combined with Department of Natural Resources & Conservation funds or Community Development Block Grant funds) are the single most common method used to fund major water and sewer improvements. Debt retirement comes through user fees, which are set after completion of a rate study. Several methods are used to set fees. Interested readers should obtain a copy of Water Rates - AWWA Manual M1, (available from the American Water Works Association, phone 303-794-7711 to purchase this book). A person with rate design experience should be hired for this very important function.

One of the great challenges in rate design is dealing with public perception of the need for rate increases. Although the governing body, their technical advisors and state or federal agencies may be aware of the need for the system improvements (from a consumer service, environmental protection, or public health standpoint), the average citizen often is not adequately informed about the need for the increase. The negative consequences of not raising rates (not making the necessary improvements) is often not apparent to the layperson.

Representatives of the local government need to present the reasons for the proposed rate increase in terms that are personally understandable to laypersons. For example, the individual citizen may need to know the answers to the following questions: Will people get sick if we don't do something? How is my family affected? Will we run out of water? Should we continue to pollute the river with our sewage or should we stop?

Another issue in designing new rates is that public perception of the need to increase rates is often based on each individual's "personal financial health". It is common in small towns for a rather high proportion of the population to be of low income or to be on fixed incomes. Thus, even when the need for improvements is appreciated, many people may feel that they do not have the capacity to pay for the increase.

Another problem in persuading citizens of the need for a rate increase is that rate payers do not have "benchmarks" available to compare the rate proposed for their town with an existing rate for another town of similar population size. They may think that going from $4.00 per month for water to $7.00/month is unfair and outrageous, but not realize that the average rate for towns in their population range is $12 per month.

There are no magic answers for these issues. However a fair, open, public discussion of the issues coupled with a well thought out and extensive public information program can help to reduce some of these problems. For example, some towns have used an "open house" to explain the importance and complexity of water/sewer treatment facilities to the public. (See Chapter 7, Public Education)

Water Meters

It is highly recommended that utilities install water meters and set up rate schedules to promote water conservation through favorable metered rates. Water meters are beneficial for the following reasons:

1. Meters reduce costs for the local government and the rate payer. Because water is a "refined" product, significant costs are added to each gallon of water that is treated, pumped, and distributed. Metering reduces consumption which significantly reduces costs for chemicals and pumping.

2. Meters are the only fair way to distribute costs. With meters, customers only pay for what they use. Without meters, some customers pay more than their share while other users receive unfair subsidies.

3. Meters promote water conservation. Usable, affordable potable water supplies are limited. It is environmentally unsound to waste water. Per capita water consumption in homes without meters is generally three times those with meters.

In order to promote customer confidence in metered billing methods, a preliminary educational effort should be made as to <u>why</u> water costs money. Also, a meter testing and replacement program should be part of the annual budget in order to maintain a high level of customer confidence in meters and to assure fair billing. Meter suppliers have excellent public education materials available that explain the benefits of metering. Contact your local water meter supplier for more information.

EVALUATING FUNDING OPTIONS AND PROGRAMS - PROCEDURE

Several options exist for funding capital improvements. Local government representatives should evaluate all available sources of financing. The general types of financing for streets, water, and sewer improvements include:

* annual budget appropriations (taxes)
* user fees
* reserve funds
* grants
* bonds (or loans)
* alternative financing

Given the complexities of each of these options, we will provide the basics on where to obtain detailed information about these various alternatives.

The funding options and programs shown on Tables 6-1 and 6-2 of this chapter are taken from the Department of Commerce Public Works Money Database, a computer listing of all known sources of funding for all types of public works. (For further information, call 444-3757) Because the programs change so rapidly, just the basic information on each program is listed. To effectively use this information:

1. Review each option and select those options that seem most applicable to your proposed improvements.

2. If necessary, call the contact person for each program for up to date details. Keep notes and set up a file for each option under consideration.

3. If the option is a grant or loan program ask about: local matching fund requirements, application procedures, what makes for a sound "fundable" project, sample applications from good previously-funded projects, special program requirements ("strings"), etc.

4. Analyze each option - What are its advantages and disadvantages? How much money will the option raise? Are the strings acceptable to the local leaders? What tasks will have to be carried out by the local government in order to use the option? How long will it take to complete each step?

5. Present the information to the local governing body in summary form - What are the alternatives? How much will they cost? Will more than one source of money be needed? What are the strings and legal requirements?

6. Seek public input.

7. Make a decision (governing body's decision) - What options will be used? How will you pay the bill?

8. Select the desired financial option for each project for each facility. Plug in the preferred option on the street water,and wastewater improvement priorities forms. Type the information on your draft Mini CIP form (see Table 5.4 in Chapter 5).

Program Name	Eligible Applicar	Funding Cycle (Deadline)	Special Require-ments	Program Contact
1. FmHA Water & Waste Disposal Loans & Grants (Federal)	Counties & Municipalities Special Purpose Districts Water/Sewer Districts Cooperatives Non-profit Corporations Fed-recognized Indian Trib	Apply Anytime—Continuous Cycle	Applicants Must be Unable to Finance Project by Other Means	Mitchel R. Copp, Chief, Community & Business Programs FmHA P.O. Box 850 Bozeman, MT 59771 (406) 585-2520
2. HUD INDIAN Community Development Block Grants (Federal)	Federal-recognized Indian Tribes	Once a year, but deadline varies	Not Applicable	Gloria Dale Lewis Hud Regional Office Indian CDBG 1405 Curtis St. Denver, Co. 80202 (303) 844-6481
3. EDA Public Works Grants (Federal)	Municipalities, Counties Indian Tribes	Applications accepted at any time. Must be tied to economic development—jobs or action or retention	Compliance with Federal Regulations	John Rogers EDA, Box 10074 Federal Bldg. Helena, MT 59626 (406) 449-5074
4. DNRC Renewable Resources Development Program (State)	Counties & Municipalities Water/Sewer Districts Commissions, Boards, Agen	Application Due in May of Year Preceding Legislative Session	Technical, Economic, Environmental, and Financial Feasibility of Project Must be Presented	John Tubbs or Anna Miller DNRC Resource Development Bureau 1520 East Sixth Avenue Helena, MT 59620-2301 (406) 444-6667
5. DNRC Water Development Program (State)	Counties & Municipalities Other Gov't Subdivisions Water/Sewer Districts Private Individuals Associations & Corporation	Application Due in May of Year Preceding Legislative Session	Technical, Economic, Environmental, and Financial Feasibility of Project Must be Presented	John Tubbs or Anna Miller DNRC Resource Development Bureau 1520 East Sixth Avenue Helena, MT 59620-2301 (406) 444-6667
6. MDHES Montana State Revolving Loan Program (State)	Municipalities Other Legally Authorized P Bodies Water/Sewer Districts Authorized Tribal Organizat Private Entities (NPS)	Application Due on Oct. 1	Must Get on Priority List 1UP Document Health/ Pollution Problems	Scott Anderson Municipal Assist. Program MDHES Water Quality Bureau Cogswell Bldg., Rm A-206 Helena, MT 59620 (406) 444-2406
7. DOC Montana Coal Board Grant & Loan Program (State)	Counties and Municipalities Local Governmental Units State Agencies Special Districts Water/Sewer Districts Fed-recognized Indian Tribe	Continuous Cycle (Applications Due Prior to Meetings)	Property Taxes Cannot be Used to Repay Loan	Murdo Campbell Montana Coal Board Department of Commerce 1424 9th Ave. Capitol Station Helena, MT 59620-0401 (406) 444-2400
8. DOC Community Development Block Grants (State/Federal)	Incorporated Cities and Tow Counties (Note: Counties May Apply of Water/Sewer Districts)	Annual Grant Competition Annual Applications Due in Fall	At least 51% of the beneficiaries of a project must be low or moderate income	Gus Byrom, Manager CDBG Program Department of Commerce 1424 9th Ave. Capitol Station Helena, MT 59620 (406) 444-2488
9. DOC Intermediate Term Capital Program (INTERCAP) (State)	Local Government Units Special Purpose Districts Water/Sewer Districts	Apply Anytime—Continuous Cycle	None	David Ewer or Debra McKee Mt. Board of Investments Capitol Station Helena, MT 59620 (406) 442-1970

TABLE 6.1 SUMMARY OF FINANCIAL OPTIONS FOR WATER & WASTEWATER PROJECTS FOR COMMUNITIES UNDER 10,000 POP.

Program Name	Eligible Applicants	Eligible Projects	Local Match Req'd	Loan or Grant?	Planning Costs Covered?	Funds Available per Project	Loan Repayment Period	Ranking Criteria	Funding Cycle (Deadline)	Special Requirements	Program Contact
1. FmHA Water & Waste Disposal Loans & Grants (Federal)	Counties & Municipalities Special Purpose Districts Water/Sewer Districts Cooperatives Non-profit Corporations Fed-recognized Indian Tribes	Water & Wastewater Systems (Construction, Repair, Expansion)	No	**Insured:** Grants and Loans **Guaranteed:** Loans Only	Reimbursement as Part of Total Project Cost	**Insured:** No Maximum for Loans; 75% Max. Grant. **Guaranteed:** No Maximum Loans; No Grants.	40 Years or Life of Facility	Priority to: Under 5,500 Population, Health Risks, Facility Expansion	Apply Anytime—Continuous Cycle	Applicants Must be Unable to Finance Project by Other Means	Mitchel R. Copp, Chief, Community & Business Programs FmHA P.O. Box 850 Bozeman, MT 59771 (406) 585-2520
2. HUD INDIAN Community Development Block Grants (Federal)	Federal-recognized Indian Tribes	Water, Sewer Systems	No	Grants	No	Varies Highest amount in 1989 was $400,000	Not Applicable	Need Other Criteria	Once a year, but deadline varies	Not Applicable	Gloria Dale Lewis Hud Regional Office Indian CDBG 1405 Curtis St Denver, Co. 80202 (303) 844-6481
3. EDA Public Works Grants (Federal)	Municipalities, Counties Indian Tribes	Water Systems, Sewer Systems	No	Grants	No	Generally not to exceed 1,000,000, but can be waived in special circumstances		8 Ranking Criteria Emphasis on: 1. Economic Distress 2. Job/Cost Ratio	Applications accepted at any time. Must be tied to economic development—jobs or action or retention	Compliance with Federal Regulations	John Rogers EDA, Box 10074 Federal Bldg. Helena, MT 59626 (406) 449-5074
4. DNRC Renewable Resources Development Program (State)	Counties & Municipalities Water/Sewer Districts Commissions, Boards, Agencies, Dept.	Water and Wastewater related Projects (Feasibility, Development, Expansion, Construction)	No	Both Loans and Grants	Yes	$200,000 Loan	30 Years or Life of Facility	Enhance Public Resources Optimize Public Benefit Need/Urgency Part of Family Farm Uses Measured Water Water Storage Project	Application Due in May of Year Preceding Legislative Session	Technical, Economic, Environmental, and Financial Feasibility of Project Must be Presented	John Tubbs or Anna Miller DNRC Resource Development Bureau 1520 East Sixth Avenue Helena, MT 59620-2301 (406) 444-6667
5. DNRC Water Development Program (State)	Counties & Municipalities Other Gov't Subdivisions Water/Sewer Districts Private Individuals Associations & Corporations	Water and Wastewater Related Projects (Feasibility, Development, Construction)	No	Both Loans and Grants	Yes	**Grants (Public):** 25% of Project Cost. Maximum Grant of $100,000. **Loans (Public):** No Maximum. Subject to Availability of Funds.	30 Years or Life of Facility	Enhance Public Resources Public Benefit Need/Urgency Conservation Project not Previously Received Funds State-wide Application	Application Due in May of Year Preceding Legislative Session	Technical, Economic, Environmental, and Financial Feasibility of Project Must be Presented	John Tubbs or Anna Miller DNRC Resource Development Bureau 1520 East Sixth Avenue Helena, MT 59620-2301 (406) 444-6667
6. MDHES Montana State Revolving Loan Program (State)	Municipalities Other Legally Authorized Public Bodies Water/Sewer Districts Authorized Tribal Organizations Private Entities (NPS)	Wastewater Systems (Interceptors, Treatment Facilities, Outfall Sewers, Infiltration/Inflow Rehabilitation) Non-point Source Control Projects Storm Sewers	No	Loans	Yes	100% Loan for Eligible Costs	20 Years or Less	Impairment of Water Uses, Extent Project Will Restore Water Quality, Public Health Improvement, Ability to Repay Loan	Application Due on Oct. 1	Must Get on Priority List IUP Document Health/ Pollution Problems	Scott Anderson Municipal Assist. Program MDHES Water Quality Bureau Cogswell Bldg., Rm A-206 Helena, MT 59620 (406) 444-2406
7. DOC Montana Coal Board Grant & Loan Program (State)	Counties and Municipalities Local Governmental Units State Agencies Special Districts Water/Sewer Districts Fed-recognized Indian Tribes	Water and Wastewater Systems (Distribution Systems, Treatment Plants, Storage Facilities)	Yes	Grants and Loans to 80%	Yes	No limitations (Project Cost Estimates Will be Reviewed by Board)	20 Years	Need Severity of Impact Availability of Funds Local Effort	Continuous Cycle (Applications Due Prior to Meetings)	Property Taxes Cannot be Used to Repay Loan	Murdo Campbell Montana Coal Board Department of Commerce 1424 9th Ave. Capitol Station Helena, MT 59620-0401 (406) 444-2400
8. DOC Community Development Block Grants (State/Federal)	Incorporated Cities and Towns Counties (Note: Counties May Apply on Behalf of Water/Sewer Districts)	Public Facilities (Water & Wastewater Systems)	No, However, increased score for at least 25% match	Grants	NO for Costs incurred Prior to Grant Award YES for Costs Associated with Engr. and Grant Administration	$375,000 for Public Facility Grants	Not Applicable	1. Needs Assessment—Citizen Participation 2. Need for Project 3. Appropriateness of Technical Design 4. Operation and Maintenance 5. Benefit to low & moderate income	Annual Grant Competition Annual Applications Due in Fall	At least 51% of the beneficiaries of a project must be low or moderate income	Gus Byrom, Manager CDBG Program Department of Commerce 1424 9th Ave. Capitol Station Helena, MT 59620 (406) 444-2488
9. DOC Intermediate Term Capital Program (INTERCAP) (State)	Local Government Units Special Purpose Districts Water/Sewer Districts	Water & Wastewater Systems (Construction, Repair, Expansion)	No	Loans	No	Minimum: $10,000 Cities; $4,000 All other local governments Maximum: $500,000 per Project	Most Loans for Five Year Terms	No Formal Criteria. However, Board examines applicant's financial profile and repayment ability.	Apply Anytime—Continuous Cycle	None	David Ewer or Debra McKee Mt. Board of Investments Capitol Station Helena, MT 59620 (406) 442-1970

TABLE 6.1 (Continued) SUMMARY OF FINANCIAL OPTIONS FOR WATER & WASTEWATER PROJECTS FOR COMMUNITIES UNDER 10,000 POP.

Program Name	Eligible Applicants	Eligible Projects	Type of $ (Loan, Grant, Bond, Other)	Funds Available per Project	Special Requirement	Program Contact
10. Revenue Bond (Local Govt.)	Municipalities	Water, Sewer Systems	Bond	Tax debt cannot exceed 55% over and above 28% of taxable	See 7-7-4202 MCA.	City Attorney or Alec Hansen Mt. League of Cities, P.O. Box 1704 Helena, Mt. 59624 (406) 442-8768
11. General Obligation Bond (Local Govt.)	Municipalities	Water, Sewer Systems	Bond	Limited to 28% of Taxable value + additional 55% for Water/Sewer Projects	See 7-7-4201 MCA. Requires Voter Approval.	City Attorney or Alec Hansen Mt. League of Cities P.O. Box 1704 Helena, Mt. 59624 (406) 442-8768
12. Special or Rural Improvement Districts (Local Govt.)	Special (SID)—Municipalities Rural (RID)—Counties	Water, Sewer Systems	Special Assessment on Property Benefited	Unlimited by law	SID—See 7-12-4101 MCA RID—See 7-12-2102 MCA	SID—Same as Above RID—County Attorney or Gordon Morris, MACo 2711 Airport Road Helena, Mt. 59601 (406) 442-5209
13. County Water/ Sewer District (Local Govt.)	Unincorporated Cities and Towns, Counties, Subdivisions	Water, Sewer Systems	Bonds, User Fees, Tax Levies, or Other Charges. (A District May Use Any of These Methods)	Tax Assessments Subject to 7-13-2303 MCA	Tax Assessments Subject to 7-13-2303 MCA See 7-13-2301 MCA	County Attorney or Gordon Morris, MACo 2711 Airport Road Helena, Mt. 59601 (406) 442-5209
14. User Fee (Local Govt.)	Water/Sewer Districts Municipalities	Water, Sewer Systems	User Fee (a Periodic Charge to Users of Water and Sewer Services)	Unlimited, However, Fee Increases greater than 12% Annually Subject to PSC Approval	**Districts**—See 7-13-2301 MCA. **Municipalities**— See 7-13-4304 MCA Fees Must be Equitable	Attorney, Rate Specialist, or Ron Woods, Public Service Commission 1701 Prospect Ave. Vista Bldg. Helena, Mt. 59620 (406) 444-6199
15. System Development Fee or Plant Investment Fee (Local Govt.)	Water/Sewer Districts Municipalities	Water, Sewer Systems	Special Fees Assessed on New Users (Hook Ups) to Reimburse Community Ratepayer For Money Already invested in Water Sewer Treatment Plant	Depends on Method Used	**Districts**—See 7-13-2301 MCA. **Municipalities**— See 7-13-4304 MCA Fees must be Equitable PSC Approval needed	Attorney, Rate Specialist, or Ron Woods, Public Service Commission 1701 Prospect Ave. Vista Bldg. Helena, Mt. 59620 (406) 444-6199
16. CIP Fund (Local Govt.)	Municipalities Counties	Water, Sewer Systems	Tax (Reserve Fund)	Municipalities—5% of all purpose levy Counties—10% of only one levy	Municipalities—See 7-6-4134 MCA Counties—See 7-6-2219 MCA	Robb McCracken Mt. Dept. of Commerce, CTAP 1424 9th Avenue Helena, Mt. 59620 (406) 444-3757

:INANCIAL OPTIONS FOR MMUNITIES UNDER 10,000 POP.

Special Requirement	Program Contact
See 7-7-4202 MCA.	City Attorney or Alec Hansen Mt. League of Cities, P.O. Box 1704 Helena, Mt. 59624 (406) 442-8768
Sec 7-7-4201 MCA. Requires Voter Approval.	City Attorney or Alec Hansen Mt. League of Cities P.O. Box 1704 Helena, Mt. 59624 (406) 442-8768
SID—See 7-12-4101 MCA RID—See 7-12-2102 MCA	SID—Same as Above RID—County Attorney or Gordon Morris, MACo 2711 Airport Road Helena, Mt. 59601 (406) 442-5209
Tax Assessments Subject to 7-13-2303 MCA See 7-13-2301 MCA	County Attorney or Gordon Morris, MACo 2711 Airport Road Helena, Mt. 59601 (406) 442-5209
Districts—See 7-13-2301 MCA. **Municipalities**— See 7-13-4304 MCA Fees Must be Equitable	Attorney, Rate Specialist, or Ron Woods, Public Service Commission 1701 Prospect Ave. Vista Bldg. Helena, Mt. 59620 (406) 444-6199
Districts—See 7-13-2301 MCA. **Municipalities**— See 7-13-4304 MCA Fees must be Equitable PSC Approval needed	Attorney, Rate Specialist, or Ron Woods, Public Service Commission 1701 Prospect Ave. Vista Bldg. Helena, Mt. 59620 (406) 444-6199
Municipalities—See 7-6-4134 MCA Counties—See 7-6-2219 MCA	Robb McCracken Mt. Dept. of Commerce, CTAP 1424 9th Avenue Helena, Mt. 59620 (406) 444-3757

Program Name	Eligible Applican
1 Highway Traffic Safety Program (Federal/State)	Municipalities, Counties
2 Federal Aid Secondary Roads (Federal/State)	Counties
3 Federal Aid Urban System (Federal/State)	Municipalities of those Under 10,000 POP. Only the Following Qualify: Miles City, Lewistown Livingston, Anaconda, Glendive, Sidney, Laurel
4 Metropolitan Planning Funds (PL funds) (Federal/State)	Municipalities of Those Under 10,000 POP. Only the Following Qualify: Miles City, Lewistown, Livingston, Anaconda, Glendive, Sidney, Laurel For Federal Aid System Roads—Not Local Roads
5 EDA Public Works and Development Grants (Federal)	Municipalities, Counties, Indian Tribes
6. Gas Tax (State)	Municipalities, Counties
7. Montana Coal Board (State)	Municipalities, Counties, Special Districts, Federal—Recognized Indian Tribes
8. Special or Rural Improvement Districts (Local Govt.)	Special (SID) Municipalities Rural (RID) Counties
9 Local Option Gas Tax (Local Government)	Municipalities, Counties

TABLE 6.2 SUMMARY OF FINANCIAL OPTIONS FOR STREET AND ROAD IMPROVEMENTS FOR COMMUNITIES UNDER 10,000 POP.

Program Name	Eligible Applicants	Eligible Projects	Type of $ (Loan, Grant, Bond, Other)	Funds Available per Project	Special Requirements	Program Contact
1. Highway Traffic Safety Program (Federal/State)	Municipalities, Counties	High Traffic Accident Location Studies No Construction Funds	Grant	Not Applicable	No Construction Funds Available	Harry Lauer Mt. Dept. of Justice, Highway Safety 303 N. Roberts, Helena, Mt. 59620 (406) 444-3412
2 Federal Aid Secondary Roads (Federal/State)	Counties	Construction or Repair of Roads on the FAS System	Other—The Dept. of Transportation Builds the Road For the County Government	Unlimited by Statute	The Need to be Constructed Repaired Must be Designated as Being on the FAS System	Larry Williams Mt. Dept. of Transportation Rail & Transit Division 2701 Prospect Ave. Helena, Mt. 59620 (406) 444-6110
3. Federal Aid Urban System (Federal/State)	Municipalties of those Under 10,000 POP Only the Following Qualify: Miles City, Lewistown Livingston, Anaconda, Glendive, Sidney, Laurel	Construction of Streets and Related Items, Preliminary Engineering, ROW—Utilities	Other—The Dept. of Transportation Builds the Street For the Municipality	Varies	Must Comply With Federal/State Regulations	Bill Cloud Mt. Dept. of Transportation 2701 Prospect Ave. Helena, Mt. 59620 (406) 444-6125
4 Metropolitan Planning Funds (PL funds) (Federal/State)	Municipalties of Those Under 10,000 POP Only the Following Qualify. Miles City, Lewistown, Livingston, Anaconda, Glendive, Sidney, Laurel For Federal Aid System Roads—Not Local Roads	Planning Street Improvements	Grant	Varies	Must Comply With Federal/State Regulations	Bill Cloud Mt. Dept. of Transportation 2701 Prospect Ave. Helena, Mt. 59620 (406) 444-6125
5 EDA Public Works and Development Grants (Federal)	Municipalities, Counties, Indian Tribes	Construction or Repair of Streets to Allow the Establishment of Commercial Businesses	Grant	Generally not to exceed $1,000,000, but can be waived in special circumstances	Has to be tied to economic development project, i.e. job creation or retention. Applications accepted any time.	John Rogers Economic Development Admin. Box 10074 Federal Building Helena, Mt. 59626 (406) 449-5074
6 Gas Tax (State)	Municipalities, Counties	Street, Road Projects including Curb and Gutter and Drainage	Entitlement Grant	Varies (Predetermined Formula)	Not Applicable	Larry Williams Mt. Dept. of Transportation Rail & Transfer Division 2701 Prospect Ave. Helena, Mt. 59620 (406) 444-6110
7 Montana Coal Board (State)	Municipalities, Counties, Special Districts, Federal—Recognized Indian Tribes	Expansion of Roads/Streets Needed as a Result of Coal Mining Development	Grants and Loans to 80% of Project Cost.	Although no Limits on Requests, very Little Money Available	Application Due 30 Days Prior to Board Meetings	Murdo Campbell Mt. Coal Board Mt. Dept. Commerce 1424 9th Ave. Capitol Station Helena, Mt. 59620 (406) 444-2400
8 Special or Rural Improvement Districts (Local Govt.)	Special (SID) Municipalities Rural (RID) Counties	Streets, Road Projects	Special Assessment on Property Benefited	Unlimited by Statute	SID—See 7-12-4101 MCA RID—See 7-12-2101 MCA	SID—City Attorney or Alec Hansen Mt. League of Cities P.O. Box 1704 Helena, Mt. 59624 (406) 442-8768 RID—County Attorney or Gordon Morris, MACo 2711 Airport Road Helena, Mt. 59601 (406) 442-5209
9 Local Option Gas Tax (Local Government)	Municipalities, Counties	Street, Road Projects	Tax	Tax Limited to Maximum of $0.02 per Gallon of Gas	See 7-14-301 MCA Requires Voter Approval	Municipalities—City Attorney or Alec Hansen Mt. League of Cities P.O. Box 1704 Helena, Mt. 59624 (406) 442-8768 Counties—County Attorney or Gordon Morris, MACo 2711 Airport Road Helena, Mt. 59601 (406) 442-5209

TABLE 6.2 (Continued) SUMMARY OF FINANCIAL OPTIONS FOR STREET AND ROAD IMPROVEMENTS FOR COMMUNITIES UNDER 10,000 POP.

Program Name	Eligible Applicants	Eligible Projects	Type of $ (Loan, Grant, Bond, Other)	Funds Available per Project	Special Require-ments	Program Contact
10. Multijursdictional Service District (Local Government)	Municipalities, Counties	Road, Street, Highway Maintenance	Tax	Unlimited by Statute	See 7-11-1101 MCA Creation of District Subject to Property Owner Protest Rights	Municipalities— City Attorney or Alec Hansen Mt. League of Cities P.O. Box 1704 Helena, Mt. 59624 (406) 442-8768 Counties— County Attorney or Gordon Morris, MACo 2711 Airport Road Helena, Mt. 59601 (406) 442-5209
11. Street Maintenance Districts (Local Government)	Municipalities	Street Repairs and Maintenance	Special Assessment on Property Benefited	Unlimited by Statue	See 7-12-4401 MCA	Municipalities— City Attorney or Alec Hansen Mt. League of Cities P.O. Box 1704 Helena, Mt. 59624 (406) 442-8768
12. CIP Fund (Local Government)	Municipalities, Counties	Street, Road projects	Tax (Reserve fund)	Municipalities—5% of all purpose levy Counties—10% of any 1 levy	Municipalities— See 7-6-4134 MCA Counties— See 7-6-2219 MCA	Robb McCracken Mt. Dept. of Commerce 1424 9th Ave. Helena, Mt. 59620 (406) 444-3757
13. Road and Bridge Depreciation Fund (Local Government)	Counties	Street, Road projects	Tax (Reserve fund)	Reserve may not exceed $200,000	See 7-14-2506 MCA	Gordon Morris MACo 2711 Airport Road Helena, Mt. 59601 (406) 442-5209

FINANCIAL OPTIONS FOR OMMUNITIES UNDER 10,000 POP.

Special Requirements	Program Contact
See 7-11-1101 MCA Creation of District Subject to Property Owner Protest Rights	Municipalities— City Attorney or Alec Hansen Mt. League of Cities P.O. Box 1704 Helena, Mt. 59624 (406) 442-8768 Counties— County Attorney or Gordon Morris, MACo 2711 Airport Road Helena, Mt. 59601 (406) 442-5209
See 7-12-4401 MCA	Municipalities— City Attorney or Alec Hansen Mt. League of Cities P.O. Box 1704 Helena, Mt. 59624 (406) 442-8768
Municipalities— See 7-6-4134 MCA Counties— See 7-6-2219 MCA	Robb McCracken Mt. Dept. of Commerce 1424 9th Ave. Helena, Mt. 59620 (406) 444-3757
See 7-14-2506 MCA	Gordon Morris MACo 2711 Airport Road Helena, Mt. 59601 (406) 442-5209

NEW IDEAS IN FINANCING

Privatization Alternatives

If the previously listed methods of financing a project are unacceptable for some reason, it is possible to use alternative, or creative methods of financing. There are a number of different options that could be pursued. This section is by no means intended to be comprehensive.

"Privatization"is an agreement where a private investor or company will obtain an interest in a public sector facility by being the financier, lessor, lessee, operator, owner, or any combination thereof. Privatization can include one of the following forms:

1. The public sector owns the facility and it is operated by the private sector.

2. The public sector designs the facility, it is built with private sector funds and then operated by the public sector.

3. Option 2 above with a private sector operator.

4. The private sector designs the facility, arranges financing, gets public sector acceptance and approval, and then the private sector operates it.

5. Option 4 above except the public sector operates the facility.

Obviously, the list can be lengthened, but for our purposes we have defined "privatization" adequately. "Privatization" has been used for financing a few water and sewer systems. There are few examples of government owned streets or roads that have been successfully "privatized." It is technically difficult and may be unpopular to attempt to "privatize" streets and roads. For further information, interested local officials should contact an attorney or a financial brokerage firm who has experience in public works privatization.

Fund Raising And Other New Ideas

A local government can use other financing mechanisms to pay a small portion of the improvement costs. To help pay for pothole repair, a few municipalities have created "adopt a pothole" programs. Since there is never enough tax money to fix all the potholes, property owners can purchase the repair of a pothole in the street adjacent to their property. Under this approach the property owner pays $5, $10, or $15 per pothole (depending on the size). In return the municipality guarantees patching of the pothole in 48 hours (as opposed to a waiting period of several years if tax money is used).

Other ideas such as "adopt a fire hydrant", "adopt a park", or "work a free day with the local government" are also possible. These programs may provide limited amounts of new money to pay for public works repairs.

FINANCIAL DEPRECIATION

Definition of Financial Depreciation

Water, sewer and street systems wear out and deteriorate similar to other man made

products such as machines, cars, or buildings. To deal with normal ongoing long-term deterioration of water, sewer, and street systems, the local government needs to financially plan for future major replacements. It is possible to roughly gauge when various system components may fail in the future, based on public works needs assessments and accounting guidelines for estimating the useful life of major water, sewer, and street components. Knowing this, it is possible for the local government to reserve money and plan ahead so that when major portions of the system are beginning to wear out in the future money is available to fix the system. This procedure is called "financial depreciation" in the local government context.

Financial depreciation is a well tested accounting and management tool that has been used by most private businesses for over 40 years as an incentive to replace business plants, buildings, and other facilities. While it is a new idea for government managers, it is a technically sound procedure.

In the private business context, financial depreciation is an accounting tool used to estimate the extent to which a capital facility ("fixed asset") wears out annually. Federal income tax breaks are provided businesses that use depreciation schedules. The resulting savings in taxes can be used or invested by private businesses to help offset the costs of replacing fixed assets such as factories, buildings, and machinery.

In the local government context, the financial depreciation process works somewhat differently. Local governments do not pay federal income taxes nor do they receive income tax breaks. However, the fundamental principle involved -- accounting for annual deterioration of a capital facility and setting up an ongoing means to help finance replacement of the facility -- is similar to the private business context. For local governments the depreciation schedule for a specific facility, such as a water system, can be established. Then the user fee or taxes used to finance ongoing operation of the facility are adjusted or increased to incorporate earmarked funds to pay for the replacement of the facility. The replacement funds are set aside in a reserve fund or the capital improvement program fund authorized by Montana law. The reserve funds gradually build up in direct proportion to the gradual deterioration of the facility. When facility replacement is necessary, funds are available.

Benefits of Financial Depreciation Schedules

According to many national and Montana public works financing experts, most major public works replacement financing problems can be avoided if local governments set up ongoing depreciation schedules and replacement funds to help pay for facility replacement. The experts stress several specific benefits of the use of depreciation schedules. First of all, there is a tendency for the busy governing body to forget that the entire facility is wearing out. Members of governing bodies serve for short periods of time and have a hard time planning for replacement projects which extend beyond their term of office. One benefit of using depreciation is that it is an automatic constant reminder of the financial cost of and need for facility replacement.

A second benefit of the use of depreciation schedules is that it reduces the financial "pain" of user fee increases. Through the use of depreciation schedules, replacement costs are gradually reserved over a period of years. In contrast, if user fees do not account for depreciation, then major facility replacements often cause huge user fee increases all at one time. Often, the increases are from 50% to 500% or more. This often sets off taxpayer revolts in small towns. In other words, if depreciation is not gradually factored into the user fee or tax collected, the amount charged the customer is artificially underpriced because the true cost of the service is not being charged. The true cost is only being delayed until severe problems or breakages occur and then the price will go up several times to

compensate for years of underpricing.

A third benefit of depreciation and deposit of replacement funds in an earmarked account is that it reserves money for replacement so that money is available when it is needed. In contrast, without depreciation and deposit of replacement funds many local governments cannot make replacements without long delays (often delays of years) because of the lengthy procedures required to obtain bond, loan or grant financing. Thus replacement needs go un-met and postponement of replacements may actually cause other parts of the system to wear out faster (and cost more) than would ordinarily be the case. Bonds, grants and loans are appropriate financing in certain circumstances but are not substitutes for an ongoing depreciation replacement program.

Legal Authority to Create Financial Depreciation Schedules

Municipalities

Municipal governments are authorized to incorporate replacement and depreciation into water and sewer user fees under 7-13-4307, MCA. However, there are PSC restrictions on this authority.

County Water and Sewer Districts

Districts are authorized to incorporate depreciation into their water and sewer user fees in 7-13-2301(2), MCA, and replacement costs under 7-13-2301(3), MCA.

Counties

Counties may create road and bridge depreciation reserve funds under 7-14-2506, MCA.

How to Set Up a Financial Depreciation Schedule - Overview

The following are the steps in setting up a local government financial depreciation accounting and replacement system:

1. Determine dates (years) when major facility replacements will be necessary. The replacement dates may be rough. The dates are only a benchmark for reserving money. (See Appendix I for accounting guidelines on dates for water, wastewater, and street replacement.)

2. Set up a depreciation schedule. The schedule shows the amount of money needed, facility replacement dates, etc. The final Mini CIP can serve as a basis for the schedule. However, the Mini CIP shows needs for only 5 years into the future. Depreciation schedules can be set up to project costs for whatever timeframe is necessary to fund a major replacement -- 15 to 40 years, for example. An accountant should be consulted to assist you in setting up a depreciation schedule. An engineer should also be consulted. Inflation (a "negative" factor) and interest earnings (a "positive" factor) need to be considered in computing the depreciation schedule, amount of reserve money, and necessary user fee increases. The amount of reserved funds needed and the amount of the user fee increase also need to be calculated. An accountant can provide specific advise on how to factor these elements into your depreciation program.

3. Set up earmarked depreciation revenue reserve funds. For water and sewer facilities: raise the monthly user fee an amount necessary for replacement. This

depreciation/replacement money should be deposited in an earmarked account. For streets or roads: designate part of the annual street revenue for replacement. This depreciation/replacement money should be deposited in a street or road reserve account. Setting up the earmarked replacement accounts and placing the depreciation/replacement money collected in the accounts on a regular basis is crucial to the success of the depreciation replacement method. Obviously, for the depreciation approach to work, the local government can not dip into the account for annual maintenance or for new needs unrelated to the purpose of the replacement accounts.

4. Make major replacements based on the depreciation schedule and using the money reserved in the depreciation accounts.

Restraints in Using Depreciation Schedules

Municipal Governments The legal restraints on the creation of financial depreciation schedules are:

1. Statutory limits on the CIP fund (the CIP fund is a special kind of public works replacement account) -- Under 7-6-4134, MCA a municipality's CIP fund is limited to 5% of the all purpose mill levy.

2. Statutory limits on the amount of money that can be reserved in the general fund (to set up a street replacement reserve account) -- Under 7-6-4230(2) MCA reserve funds are limited to 1/3 of the total amount appropriated and authorized to be spent from the fund during the current fiscal year.

3. Public Service Commission (PSC) Policies -- Historically, the PSC has restricted the incorporation of depreciation and replacement factors into municipal water/sewer rates.

4. Initiative 105 (I-105) -- In general, under I-105 municipal taxing authority is "frozen." Thus, a municipality cannot reserve replacement and depreciation money for streets using a tax increase. However, special improvement districts and street maintenance districts can be used because they are exempt from I-105. (I-105 does not restrict water and sewer rates because they are user fees, not taxes.)

Despite these limitations, municipalities are encouraged to consult with their engineer, accountant and the Public Service Commission regarding the feasibility of setting up a reasonable depreciation schedule.

County Water and Sewer Districts

In general, I-105 forbids tax increases, thus, preventing a district from increasing taxes to be used for depreciation and replacement. However, water and sewer user fees are not subject to I-105, thus, user fees can be increased for depreciation and replacement purposes.

Counties

County road and bridge depreciation reserve funds are limited by 7-14-2506, MCA to "the money that has not been expended or encumbered for a fiscal year." Under 7-14-2501, MCA the amount of taxes raised by the road mill levy is limited to 15 or 18 mills. In general, under I-105 county taxing authority is frozen. However, depreciation and replacement money could still be raised using rural improvement districts or local

improvement districts (which are not subject to I-105).

EPA Funded Sewer Projects and Depreciation

The Environmental Protection Agency (EPA) requires that sewer projects funded by EPA must include a replacement cost factor (depreciation factor) in the user fee. For further information or help setting up such a user fee contact: Scott Anderson, Montana Department of Health, Water Quality Bureau, (406) 444-2406.

Further Information

Because of the legal and accounting complexities of setting up depreciation schedules, we will not provide detailed instructions in this book. Local governments interested in creating a depreciation schedule and earmarked replacement fund should contact an accountant. Assistance from the Department of Commerce may be available. Municipal governments should contact the Public Service Commission as to current policies on the use of depreciation schedules and reserve funds for water and sewer facilities.

Farmers Home Administration publishes a most helpful resource book which discusses depreciation. The book is Accounting for Rural Water Systems, A Practical Approach by Steve Fite, CPA (Farmers Home Administration: Washington, April 1980). It is available from the U.S. Government Printing Office, Superintendent of Documents, at (202) 783-3238. Ask for publication # 1982-566-346/15. While the book deals with water systems, it is very easy to apply the same approach to sewer systems.

See Appendix I for further details on depreciation for local government water, wastewater, and street facilities.

SUMMARY

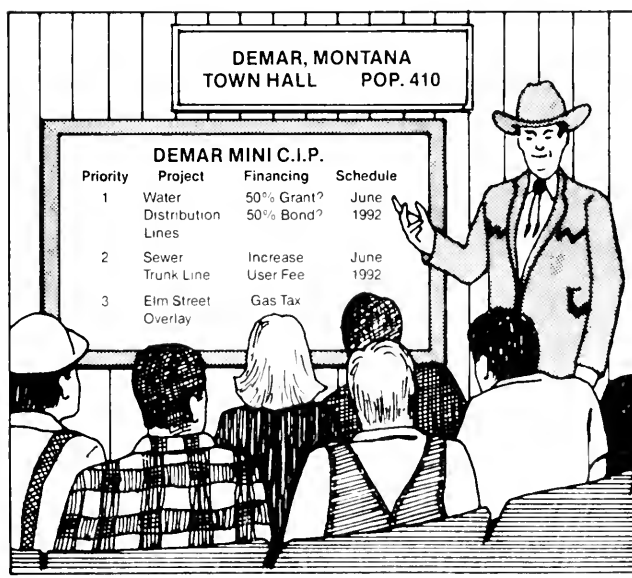
The financing process is usually the most difficult and frustrating part of maintaining and improving your public facilities. Due to many causes, delays are common. Projects may generate an amazing amount of controversy within the community. Stress on local officials and their staff may be intense. It is important not to get emotionally "burnt out". Take a longer term view and keep trying.

Having a logical, phased Mini CIP helps because it puts many of the answers to the hard and controversial financial questions at the fingertips of local decision makers and citizens. Having the Mini CIP also illustrates to the citizens that the local government is trying to fulfill its obligations to its customers in a financially efficient, "least cost" and common sense manner. Most citizens are not informed about public works issues and consequences. Developing a Mini CIP is an effective way to educate the public about the hard choices which must be made by the community through its elected leaders.

Finally, you must recognize that financing improvements is a continual process. The Mini CIP needs to be updated each year. Each year a new local budget must be approved. New public works needs may arise. New state or federal regulations often mean that a local government will have to finance a new improvement. Thus, it is critical that someone be formally designated by the local government to coordinate the financing process and update the Mini CIP.

CHAPTER SEVEN

PUBLIC EDUCATION AND INVOVEMENT



OVERVIEW OF CHAPTER

As described in Chapter 5, public support of the Mini Capital Improvements Plan (CIP) is the most essential element of the entire planning and financing process. Ultimately, the citizen will pay for the improvements and must be convinced that such improvements are necessary. The best, most logical Mini CIP may be rejected by the ratepayers and taxpayers due to lack of public awareness of infrastructure problems.

Many citizens are unaware of the most fundamental public works issues including: scope of the problems, health and legal consequences of not making repairs (health risks, fines levied by the State), short term costs versus long term savings, what are "fair" rates for services, how facility repairs can be made affordable, etc. Thus, local leaders have to work extra hard to inform and educate citizens on these issues. This chapter will outline the process for involving the public.

START EARLY

One of the biggest mistakes that you can make is to fail to adequately inform the public about the public works needs from the very beginning of the project. The time to begin the education process is as soon as the public works director and the governing body are aware that there is a need for major repairs or improvements. Sometimes, at the outset, information about the needs and costs maybe sketchy. Nevertheless, it is important that the public be provided with what information is available.

PROVIDE EASY TO UNDERSTAND INFORMATION

Improving and financing water, sewer, and street facilities often is a complex process. One job of local officials is to make sure that the citizens are provided with the "heart" of each issue. In short, keep your public education "message" simple and focus on the "big picture." Don't let your message get too complicated with complex technical details or terminology. Your message should concentrate on basic issues such as: the need for the improvements, the consequences of not making the improvements (such as health risk, higher operating costs, state or federal lawsuits), benefits of the project to the public, and costs of the project.

CONTINUAL PROCESS OF EDUCATION (REPEAT YOUR MESSAGE)

Individual citizens find out about a community need or proposed project in a variety of ways. Many people don't get "the word" at first. They may be busy at work or out of town. Some persons don't read newspapers. Others may not watch TV very much. Therefore, you must use a variety of education methods and continually repeat your message. Repeat, repeat, and repeat your message.

THE PROCESS FOR ACHIEVING PUBLIC INVOLVEMENT

The public works director is often required to become a "spokesman" for local public facilities needs. The following are techniques which maybe used to educate the public and to achieve public support.

1. Start early in the process to inform and educate the public. Do not "hit the

citizens" with a final plan just before a governing body vote on the issue. People support projects in which they have been involved and in which they see personal benefits. Public education must be a continual process.

2. Have sound technical information. No one can argue with the facts. Historical maintenance cost records and engineering studies are very valuable at this point. Provide the citizens with concise written summaries of the needs, proposals, benefits and consequences.

3. Have relevant data available when you start the public information phase of the Mini CIP. Project Summary Sheets as described in Chapter 5 are extremely helpful in explaining project needs. Type up a preliminary Summary Sheet for each individual project before going "public" with your information. The Summary Sheet should contain:

    a. Name of Proposed Project

    b. Location of Project

    c. Description of Project

    d. Condition of Existing System

    e. Statement of Why the Improvements are Necessary and What the Consequences Will Be if the Improvements Are Not Made

    f. Land Acquisition/Easements Required

    g. Adherence to Comprehensive Plan (Input from Planning Board)

    h. Anticipated Benefits

    i. Anticipated Construction Cost

    j. Cost Per Person (Per Household)

    k. Annual Operation and Maintenance Costs

    l. Potential Funding Sources

    m. Anticipated Tax and Economic Effects of Project

4. Approach the governing body with your preliminary information. Stress the need for the project, the benefits, and the economic payback. Explain the consequences of not doing the project. For example, it is often far more expensive to make temporary repairs ("patches") to water mains than to replace the mains.

5. After receiving the governing body's support, carry out a comprehensive public education program. The public education program should be a team effort. The governing body, public works director, lead financial researcher, finance officer, and planning board should be involved.

THE PUBLIC EDUCATION PROGRAM

Resource materials are available through the American Water Works Association (AWWA), the Water Pollution Control Federation (WPCF), the American Public Works Association

(APWA), and the Montana Rural Water Association (MRWA). See the end of this Chapter for addresses for these organizations. Use these materials to help you set up a public education program. You can use the following techniques for public education.

1. Insert "bill stuffers" to go out with utility bills which explaining the functions of the Public Works Department (or County Water/Sewer District). The AWWA has particularly helpful "bill stuffers."

2. Initiate a school education program with the help of the school principal, environmental education coordinator, or biology teacher. Arrange for school tours of community treatment facilities. Both AWWA and WPCF have excellent school education packages available at very nominal rates. These include "picture" books, teachers' guides, and posters written in understandable terms for various age groups of children. Remember, the children are the ratepayers of the future!

3. Consider setting up periodic "open houses" to educate the public on the importance and complexities of water and sewer treatment. A public open house can also include a tour of a troublesome street intersection or other problems with the streets.

4. Develop a visual aid program, usually a slide show, that you can show to civic groups. The slides should include pictures of typical problems that the public does not see, such as corroded bolts, old tapping saddles, corroded water mains, infiltrating manholes or sewer pipe segments (from television records of the sewer), and street potholes.

5. Develop a collection of water system and sewer system components showing what new components look like as opposed to old deteriorated ones. An example is a new mechanical joint bolt versus a corroded one.

6. After rehearsing your slide show, take the presentation to the governing body. Seek their input. Seek their approval.

7. After receiving governing body approval, take the presentation to civic groups that might be interested in the cause of infrastructure improvements. These groups may be the Elks, Civitans, Rotary, Chamber of Commerce, a church group, the League of Women Voters, or a neighborhood council. Members of the governing body and the lead financial researcher should be involved with these civic group presentations.

8. Consider, with your elected officials, developing a Capital Improvements Planning Advisory Committee to achieve full citizen participation. The planning board can fulfill this function [Sec. 76-1-601(4) and 76-1-106(2)(6), MCA].

9. Call the local TV station which serves your town. Invite a TV reporter over to see the water, sewer, and street repair needs. Explain the public needs. Explain the problems to the reporter. Explain the consequences to the town if nothing is done. Explain the savings to the taxpayers if a rational Mini CIP is adopted. Make sure you have your facts straight before you call the reporter.

10. Consider, with your elected officials, the possibility of conducting informal public information meetings regarding the Mini CIP. This provides the opportunity to see where political problems lie before proceeding with the labor intensive pursuit of funding. This process may allow you to "count your chickens before they hatch", and help you modify your education program, if necessary, to increase public support for your projects.

11. Publish a draft copy of the Mini CIP and Summary Sheets in the local newspaper. Make sure you explain why the projects are needed and the consequences to the community if the projects are not completed. Include pictures of problems with existing facilities.

12. Send a special letter to the citizens explaining the town's infrastructure repair needs and the benefits of making the necessary repairs. Include pictures or photographs. People respond well to pictures.

13. Set up a "photo board" display. A photo board is a series of photographs arranged on a cork board or similar display board with captions for each photo. The photos and captions can illustrate and explain the problems and repair needs of your water system, sewer system, or streets.

14. Repeat, repeat, and repeat your message.

BIBLIOGRAPHY OF RESOURCES AVAILABLE

The following organizations have excellent visual aid packages, information kits, brochures, or catalogs for use in public education and school education programs. The reader is encouraged to contact these organizations and obtain copies of these materials.

1. American Waterworks Association
   Publications Department
   6666 West Quincy Avenue
   Denver, CO 80235
   Telephone: (303) 794-7711

2. Rural Technical Assistance Program
   Department of Civil Engineering
   Montana State University
   Bozeman, MT 59717-0007
   Telephone: 994-6100
   1-800-541-6671 (in Montana)

3. Water Pollution Control Federation
   Publications Department
   601 Wythe Street
   Alexandria, VA 22314
   Telephone: (703) 684-2349

4. American Public Works Association
   Publications Department
   1313 East 60th Street
   Chicago, IL 60637
   Telephone: (312) 667-2200

5. Montana Rural Water Association
   Ray Wadsworth, Director
   925 7th Avenue South
   Great Falls, MT 59405
   Telephone: 454-1151

6. Midwest Assistance Program
   Bill Leonard
   P.O. Box 1456
   Whitefish, MT 59937
   Telephone: 862-3600

7. EPA National Small Flows Clearinghouse
   P.O. Box 6064
   Morgantown, WV 26506-6064
   Telephone: 1-800-624-8301

CHAPTER EIGHT

FORMALLY ADOPTING AND UPDATING THE CIP

ADOPTION OF THE MINI CIP

The governing body should adopt the Mini CIP by resolution or by ordinance after conducting preliminary public meetings and holding at least one formal public hearing. In addition, the governing body should adopt year 1 of the Mini CIP as part of the annual budget. The simple way to do this is to adopt the Mini CIP at the same time the annual budget is adopted. Each following year the governing body should adopt the next year of the Mini CIP as part of the annual budget.

ANNUAL REVIEW AND UPDATE

It is important that the Mini CIP be reviewed on an annual basis. Several factors necessitate such periodic revisions, among them:

1. Inflationary trends will increase the cost of projects, thus requiring that financial data be modified.

2. The need for new projects may come to your attention, requiring that they be added to the list. For example, new state or federal regulations may require your local government to make new improvements.

3. Projects which have been completed should be removed from the list.

4. The unanticipated receipt of a grant or an increase in local revenues may cause you to change the timing of a particular project.

5. The interest of a business in locating in part of your community may cause you to add a previously unanticipated project to the list.

6. Planned projects may be delayed due to circumstances beyond your control.

In order to simplify the process of updating your Mini CIP you may want to utilize a three-ring binder notebook or similar format. Such an approach will permit you to remove, revise, and replace a specific Project Summary without affecting the others. Here are some additional hints for updating your Mini CIP:

* Keep the Mini CIP simple. It's easier to update.

* Attach a copy or summary of it to your annual budget document. Some local governments attach a one-page Mini CIP table to the budget.

* Designate a CIP coordinator to make sure annual updates are completed.

BRIEFING NEW OFFICIALS AND STAFF ON THE MINI CIP

For the Mini CIP to work over the long run, newly elected officials and new staff need to understand the capital improvements process and the Mini CIP. The chief elected official and the CIP coordinator need to brief newcomers on the process, the status of pending projects, and the costs and benefits of making improvements.

APPENDIX A

STREET SYSTEM ANALYSIS FORMS

EXAMPLE
PAVED STREET

FIGURE I

DATA SUMMARY FORM

DATE

LOCATION

Average Total Distress Points_____
Riding Quality_____
SCI *=100-Total Dist. Pts._____

Street Name_____
From_____To_____
Section No._____Length (to tenths of mile)_____

FUNCTIONAL ADEQUACY

Surface Type_____Paved_____Unsurfaced_____
Surface Width_____No. of lanes_____Median Width_____
Parking on Street Yes No Sidewalks Yes No
at curb
detached

Average daily traffic_____
Drainage Storm Sewer V Gutter
Unpaved Side Ditch Paved Side Ditch
Curb and Gutter

STRUCTURAL ADEQUACY

Date of Construction_____
Maintenance History:
Surface Overlay_____
Seal Coat_____
Crack & Joint Maintenance_____
Estimated Cost_____
Comments_____
_____
_____
Work Order Category_____

*SCI - Street Condition Index

100 - 81	1.	No Immediate Maintenance
80 - 66	2.	Routine Maintenance
65 - 46	3.	Overlay or Gravel
45 - 0	4.	Reconstruction

FIGURE 2

INVENTORY DATA FORM
(Flexible Pavement)

Total Distress Points _____

Street Name _____ Section No. _____

From _____ To _____

RIDING QUALITY (Check one) 1 ☐ 2 ☐ 3 ☐ 4 ☐

Types of Distress	Degree of Distress	Percentage of Area		
		1-15%	16-30%	31%+
RUTTING	Slight			
_____	Moderate			
Score	Severe			
RAVELING	Slight			
_____	Moderate			
Score	Severe			
FLUSHING	Slight			
_____	Moderate			
Score	Severe			
CORRUGATIONS	Slight			
_____	Moderate			
Score	Severe			
ALLIGATOR CRACKING	Slight			
_____	Moderate			
Score	Severe			
TRANSVERSE CRACKING	Slight			
_____	Moderate			
Score	Severe			
LONGITUDINAL CRACKING	Slight			
_____	Moderate			
Score	Severe			
PATCHING	Slight			
_____	Moderate			
Score	Severe			

Check One:
Sealed ___
Partially Sealed ___
Not Sealed ___

Check One:
Sealed ___
Partially Sealed ___
Not Sealed ___

FIGURE 3
SCORING KEY
(Flexible Pavement)

Street Name _____ Section No. _____

From _____ To _____

Types of Distress	Degree of Distress	Percentage of Area								
		1-15%			16-30%			31%+		
RUTTING	Slight	0			1			3		
	Moderate	3			4			6		
	Severe	6			8			9		
RAVELING	Slight	3			5			6		
	Moderate	6			8			9		
	Severe	9			11			13		
FLUSHING	Slight	3			5			6		
	Moderate	6			8			9		
	Severe	9			11			13		
CORRUGATIONS	Slight	3			5			6		
	Moderate	6			8			9		
	Severe	9			11			13		
ALLIGATOR CRACKING	Slight	3			6			9		
	Moderate	6			9			12		
	Severe	9			12			16		
		S	PS	NS	S	PS	NS	S	PS	NS
TRANSVERSE CRACKING	Slight	1	3	5	2	4	6	2	4	8
	Moderate	3	5	6	4	6	9	4	8	9
	Severe	5	6	9	6	9	12	8	9	12
		S	PS	NS	S	PS	NS	S	PS	NS
LONGITUDINAL CRACKING	Slight	1	3	5	2	4	6	2	4	8
	Moderate	3	5	6	4	6	9	4	8	9
	Severe	5	6	9	6	9	12	8	9	12
PATCHING	Slight	0			1			3		
	Moderate	3			4			6		
	Severe	4			9			12		

S = Sealed
PS = Partially Sealed
NS = Not Sealed

FIGURE 4
INVENTORY DATA FORM
(Unsurfaced Streets)

Total Distress Points _____

Street Name _____ Section No. _____

From _____ To _____

RIDING QUALITY (Check one) 1 ☐ 2 ☐ 3 ☐ 4 ☐

Types of Distress	Degree of Distress	Percentage of Area		
		1-15%	16-30%	31%+
CROSS SECTION	Slight			
	Moderate			
_____ Score	Severe			
DRAINAGE	Slight			
	Moderate			
_____ Score	Severe			
WASHBOARDING	Slight			
	Moderate			
_____ Score	Severe			
DUST	Slight			
	Moderate			
_____ Score	Severe			
POTHOLES	Slight			
	Moderate			
_____ Score	Severe			
RUTS	Slight			
	Moderate			
_____ Score	Severe			
LOOSE AGGREGATE	Slight			
	Moderate			
_____ Score	Severe			

FIGURE 5
SCORING KEY
(Unsurfaced Street)

Street Name _____ Section No. _____

From _____ To _____

Types of Distress		1-15%	16-30%	31% +
CROSS SECTION	Slight	3	6	11
	Moderate	5	9	15
	Severe	6	12	19
DRAINAGE	Slight	1	5	9
	Moderate	3	7	12
	Severe	4	9	16
CORRUGATIONS	Slight	3	4	9
	Moderate	5	6	11
	Severe	6	7	14
DUST	Slight	0		
	Moderate	1		
	Severe	5		
POTHOLES	Slight	4	9	16
	Moderate	7	12	22
	Severe	12	19	28
RUTS	Slight	3	6	7
	Moderate	4	7	10
	Severe	6	9	14
LOOSE AGGREGATE	Slight	1	3	4
	Moderate	2	4	7
	Severe	3	6	11

FIGURE 6

DATE:

PRELIMINARY STREET IMPROVEMENT PRIORITIES FOR _____ (TOWN NAME)

STREET	FROM	TO	SURFACE TYPE	(1) SCI	LENGTH FT.	WIDTH FT.	AREA-SQ YD(3x4)-9	WORK ORDER	0.30/YARD SLURRY	COST 4.75/YD OVERLAY OR GRAVEL	7.30/YD EST. DATE(2) RECONST. TO CONST.	SOURCE (3) OF $

(1) The lower the SCI number, the worse the condition of the street.
(2) See Chapter 5, Overview Matrix.
(3) See Chapter 6, Raising Money.

APPENDIX B

STREET SYSTEM

OPERATIONAL ANALYSIS FORMS

FIGURE 1

ACCIDENT SUMMARY

SITE NUMBER _____ ACCIDENT PERIOD _____

NUMBER OF ACCIDENTS BY YEAR

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.

NUMBER OF ACCIDENTS BY TIME OF DAY

-- AM --												-- PM --											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Object	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Violat.	Drinking	Reckless Driving	Speed	Right-of-Way	Improper Passing	Improper Backing	Improper Turning	Other

NUMBER OF ACCIDENTS BY SEVERITY

Injury				
Fatality				
Property Dam. Only				

FIGURE 2

VEHICLE TURNING MOVEMENT COUNT

FOUR-APPROACH FIELD SHEET

Time _____ to _____

N/S Street _____ Date _____ Day _____

E/W Street _____ Weather _____

P = passenger cars, stationwagons, motorcycles, pick-up trucks. Observer _____

T = other trucks. (Record any school bus as SB; other buses as B)

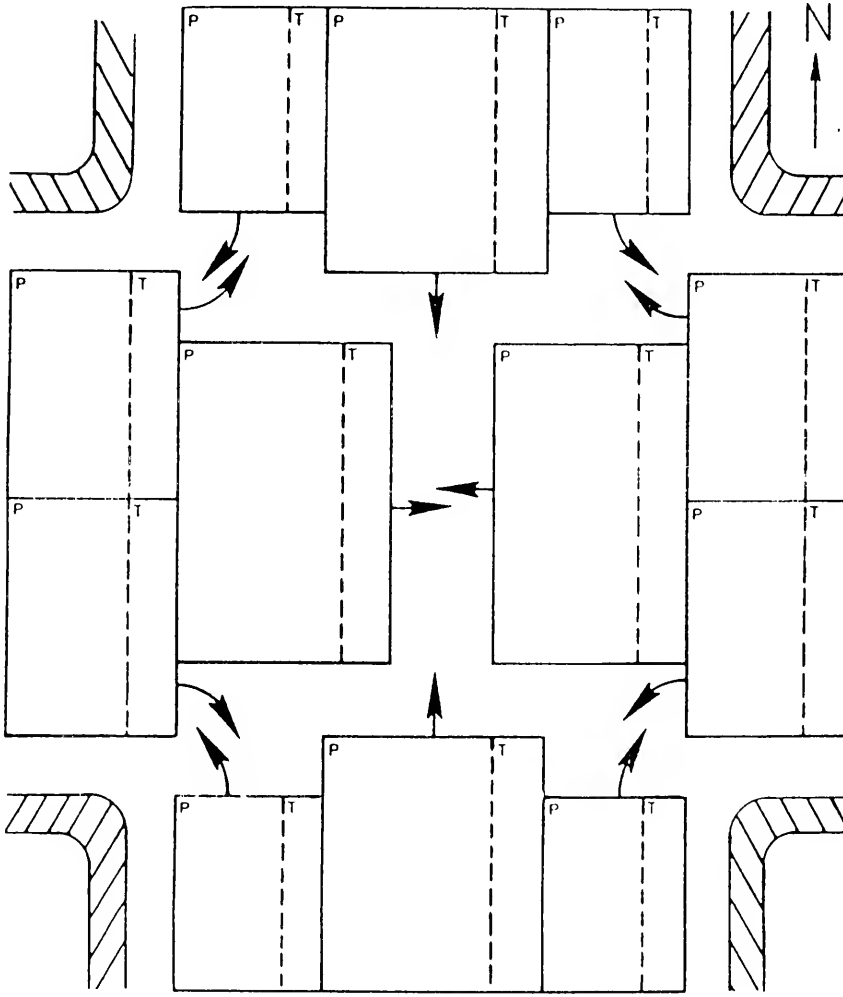


FIGURE 3

VEHICLE VOLUME SUMMARY

Station No. _____

Location _____

Date _____

Time Period _____

Weather _____

Prepared By _____

(Write street name or highway number on top of each column)

TIME	FROM NORTH ON			FROM SOUTH ON			FROM EAST ON			FROM WEST ON			INTERVAL TOTALS
	Going To			Going To			Going To			Going To			
	East	South	West	West	North	East	South	West	North	North	East	South	
7:15													
7:30													
7:45													
8:00													
8:15													
8:30													
8:45													
9:00													
11:15													
11:30													
11:45													
12:00													
12:15													
12:30													
12:45													
1:00													
4:15													
4:30													
4:45													
5:00													
5:15													
5:30													
5:45													
6:00													
TOTAL													
TOTAL OF ALL MOVEMENTS													

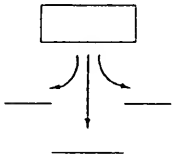
PLANNING APPLICATION WORKSHEET

Intersection:_____ Date:_____

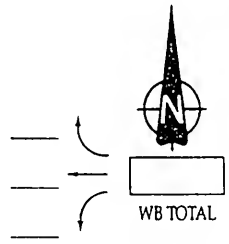
Analyst:_____ Time Period Analyzed:_____

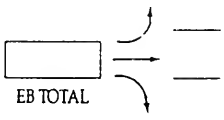
Project No._____ City/State:_____

SB TOTAL

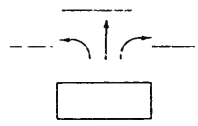


N-S STREET





E-W STREET



EB LT = _____

WB TH = _____

WB LT = _____

EB TH = _____

} OR

NB LT = _____

SB TH = _____

SB LT = _____

NB TH = _____

} OR

MAXIMUM SUM OF CRITICAL VOLUMES	CAPACITY LEVEL
0 TO 1,200	UNDER
1,201 to 1,400	NEAR
> 1,400	OVER

_____ + _____ = _____ STATUS?_____

E-W CRITICAL N-S CRITICAL

The phasing plan is relatively efficient, and the heavy NB and SB left-turn movements already have exclusive phases. While delays are undesirably high, the intersection operates at a v/c ratio of 0.95, under capacity. Geometric improvements appear to be the only reasonable direction for significant improvements. As a first step, parking might be eliminated on the E-W street. This would enable a shortening of the green phase for this street, and reallocation of additional time to the N-S street. The delay and v/c ratio for the E-W left turns, however, would have to be carefully evaluated under this option. A N-S left-turn phase might be considered, but this might actually increase delay, and the cycle length of 118.8 sec (estimated) does not appear to provide enough flexibility for addition of another phase. Construction of additional lanes on the N-S street might also be considered if right-of-way is available.

CALCULATION 4—PLANNING ANALYSIS OF AN INTERSECTION WITH MULTILANE APPROACHES

1. *Description*—The intersection of Tenth Avenue and First Street is currently a minor intersection of two 2-lane, lightly used streets. In 20 years, major development is expected to cause both streets to be reconstructed as multilane divided facilities, and the intersection will have substantial demand. Figure 9-32, the Planning Analysis Worksheet, contains a diagram of the expected intersection geometry and the forecast volumes for the intersection. Note that left-turn lanes are expected to be incorporated on each approach. Will the capacity of the proposed design be adequate?

2. *Solution*—Given the level of information available, the planning analysis technique will be applied for an approximate

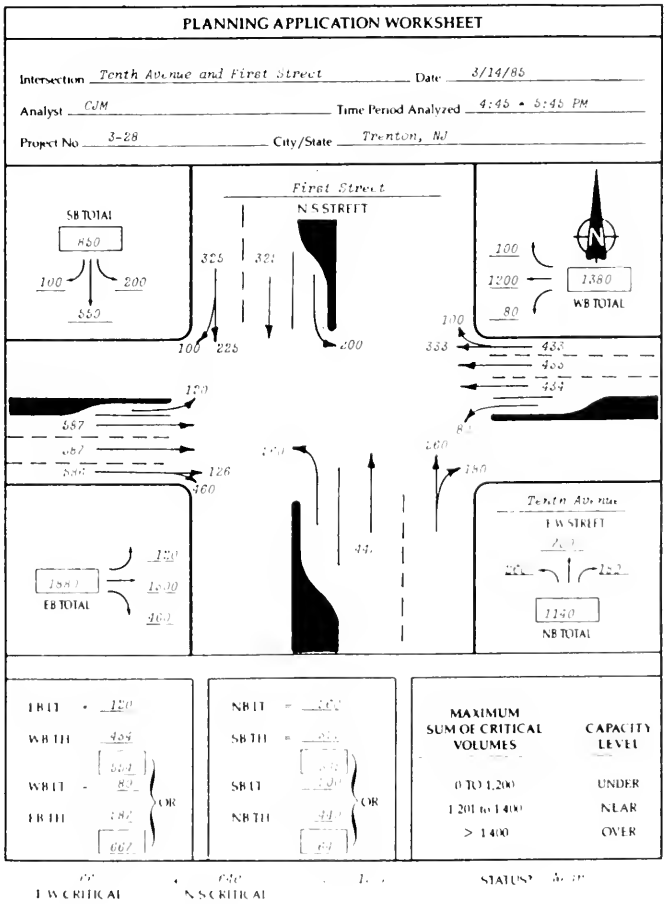


Figure 9-32. Planning analysis worksheet for Calculation 4

evaluation of the capacity of the intersection. The solution is illustrated on Figure 9-32, and is explained in a step-by-step fashion.

a. Step 1: Record Demand Volumes—The turning movement volumes for the evening rush hour have been entered on the Planning Worksheet of Figure 9-32 in the appropriate quadrants.

b. Step 2: Record Geometrics—The expected geometry has been sketched on the Planning Worksheet.

c. Step 3: Identify Lane Impedance—Left turns from shared lanes that conflict with an opposing vehicle flow are marked with an asterisk (*), indicating that the movement causes lane impedance. As all left turns are made from exclusive lanes in the proposed design, none are so marked.

d. Step 4: Assign Lane Volumes—All left turns are assigned to the appropriate left-turn lanes. The sum of right turn plus through movements on each approach is equally divided among available through lanes, and is shown on the intersection diagram of Figure 9-32.

e. Step 5: Special Procedure for Single Lane Approaches—There are no such approaches in this calculation.

f. Step 6: Determine the Sum of Critical Volumes—The critical volume for each street is the maximum sum of the left-turn movement plus the opposing per lane through or through plus right-turn movement.

Thus, sum of critical volumes is:

$$\begin{Bmatrix}\text{EB LT + WB TH}\\ \text{or}\\ \text{WB LT + EB TH}\end{Bmatrix} + \begin{Bmatrix}\text{NB LT + SB TH}\\ \text{or}\\ \text{SB LT + NB TH}\end{Bmatrix}$$

$$\begin{Bmatrix}120 + 434\\ \text{or}\\ 80 + 587\end{Bmatrix} + \begin{Bmatrix}260 + 325\\ \text{or}\\ 200 + 440\end{Bmatrix}$$

The maximum sum is given by the WB LT + EB TH (80 + 587 = 667 vph) and the SB LT + NB TH (200 + 440 = 640 vph), for a total critical volume of 667 + 640 = 1,307 vph. These values are shown in the appropriate boxes at the bottom of the worksheet.

g. Step 7: Check Capacity—The total critical volume is checked vs. the criteria of Table 9-14, which is also shown in the lower right-hand corner of the worksheet. It is seen that the critical volume is *near* capacity, i.e., in a range where it is uncertain whether or not demand will exceed capacity.

It would be desirable to provide a design which lowered the sum of critical volumes to a value under 1,200 vph to ensure that capacity will most probably not be exceeded.

The geometric suggestions of Appendix I indicate that intersection design should attempt to keep per lane volumes to 450 vph or less. This is not the case for the EB approach on the proposed design of Figure 9-32. Note that the right-turn volume is extremely high on this approach. If a right-turn lane were provided, lane volumes on the remainder of the approach could be brought below the 450-vph suggestion. Such a design is depicted in Figure 9-33, which is the worksheet for planning analysis of this proposed revision.

h. Analysis of Revised Intersection—The analysis of the revised intersection is similar to that outlined above. The only values that change are the per lane volumes on the EB approach, which are lowered because of the addition of the right-turn lane. This alters the determination of the critical volume, which is now the maximum sum among

$$\begin{Bmatrix}\text{EB LT + WB TH}\\ \text{or}\\ \text{WB LT + EB TH}\end{Bmatrix} + \begin{Bmatrix}\text{NB LT + SB TH}\\ \text{or}\\ \text{SB LT + NB TH}\end{Bmatrix}$$

$$\begin{Bmatrix}120 + 434\\ \text{or}\\ 80 + 434\end{Bmatrix} + \begin{Bmatrix}260 + 325\\ \text{or}\\ 200 + 440\end{Bmatrix}$$

The maximum sum among these is given by the EB LT + WB TH (120 + 434 = 554 vph) and the SB LT + NB TH (200 + 440 = 640 vph) for a total of 554 + 640 = 1,194 vph. Note that the critical movements on the E-W street have been altered by the proposed design change. This critical volume is *under* capacity, and is therefore acceptable.

The proposed addition of the right-turn lane would be recommended. As the design process proceeds, the volume forecasts are refined, and a signal design is developed, the intersection should be subjected to detailed operational analysis.

CALCULATION 5—PLANNING ANALYSIS OF AN INTERSECTION WITH ONE-LANE APPROACHES

1. *Description*—A large area of a semirural community has been rapidly developing, requiring a considerable planning effort to provide additional capacity at numerous intersections of low-type, formerly rural, highway facilities. The intersection of Eighth Avenue and Main Street is one such location. It is the intersection of a two-lane roadway with a four-lane roadway. No turning lanes are present on any approach. The intersection is illustrated in Figure 9-34, along with projected traffic volumes. Is it likely that capacity will be exceeded at this location?

2. *Solution*—As in calculation 4, the solution is presented in a step-by-step fashion:

a. Step 1: Record Demand Volumes—Afternoon rush-hour movements are recorded on Figure 9-34. All turning movements are noted.

b. Step 2: Record Geometrics—The geometrics are sketched on Figure 9-34. Eighth Avenue is a four-lane street with two lanes in each direction. Main Street is a two-way street with one lane on each approach.

c. Step 3: Identify Lane Impedance—Lane impedance is experienced in a shared left-turn/through lane with an opposing vehicular flow. This exists in the left lane of the EB and WB approaches and on the one-lane NB and SB approaches. Each of these movements is marked with an asterisk (*).

d. Step 4: Assign Lane Volumes—All approaches have lane impedance or shared left-turn/through lanes. Passenger car equivalent computations are performed on Figure 9-35. The assignment of lane volumes on the EB and WB approaches is in terms of equal PCE's per lane. The total volume on the NB and SB approaches is assigned to the one lane available on each. PCE computations for these movements proceed through column 8 of Figure 9-35, with the results being used in Step 5, where special adjustments are made to account for the unique operating characteristics of single-lane approaches. Lane volumes are entered on the planning worksheet of Figure 9-34.

e. Step 5: Special Procedure for Single-Lane Approaches—The SB and NB approaches are narrow single lanes with unprotected turning. The first 8 columns of Figure 9-35 are used to determine that the PCE flow is 640/hour for the SB approach (an increase of 120 vph over the actual volume of 520 vph) and

370/hour for the NB approach (an increase of 80 vph over the actual volume of 290 vph for the approach). The new PCE volumes are entered on the planning worksheet of Figure 9-34.

The number of conflicting left turns for a single-lane approach opposed by a single-lane approach is now calculated. It is assumed that left turns from one approach can be made through gaps created by opposing left turns. Thus, conflicting left turns are assumed to be only the difference between the subject left-turn volume and the opposing left-turn volume. Thus, for the SB approach, the number of left turns that conflict with the opposing through movement is estimated to be:

$$120 \text{ vph} - 80 \text{ vph} = 40 \text{ vph}$$

where it is assumed that 80 vph turn through gaps created by the opposing 80 left-turns. Similarly, the number of NB left-turns that conflict with the opposing through movement is:

$$80 \text{ vph} - 120 \text{ vph} = -40, \text{ Say } 0 \text{ vph}$$

where it is assumed that all 80 left-turns are executed through gaps created by the opposing 120 left-turns.

These adjusted conflicting left-turn volumes are entered on the planning worksheet of Figure 9-34.

f. Step 6: Calculate Sum of Critical Lane Volumes—The possible combinations of critical volumes are given as follows:

$$\begin{Bmatrix}\text{EB LT + WB TH/RT}\\ \text{or}\\ \text{WB LT + EB TH/RT}\end{Bmatrix} + \begin{Bmatrix}\text{NB LT + SB}\\ \text{or}\\ \text{SB LT + NB}\end{Bmatrix}$$

$$\begin{Bmatrix}120 + 470\\ \text{or}\\ 170 + 605\end{Bmatrix} + \begin{Bmatrix}0 + 640\\ \text{or}\\ 40 + 370\end{Bmatrix}$$

The maximum sum is given by the WB LT + EB TH/RT + NB LT + SB, which yields a critical volume of 1,415 vph (170 + 605 + 0 + 640).

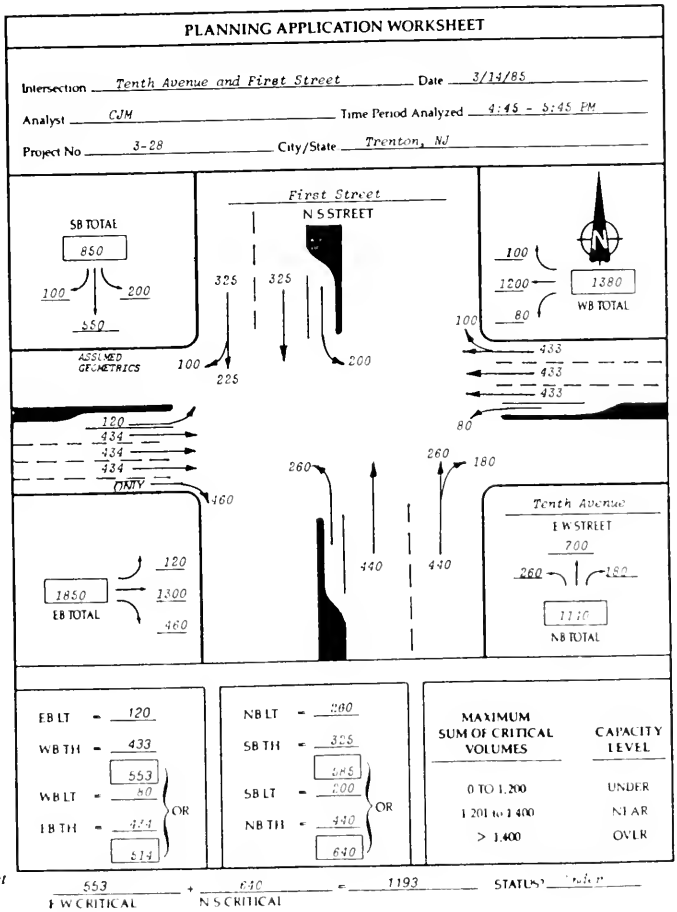


Figure 9-33. Planning analysis worksheet for revised design of Calculation 4.

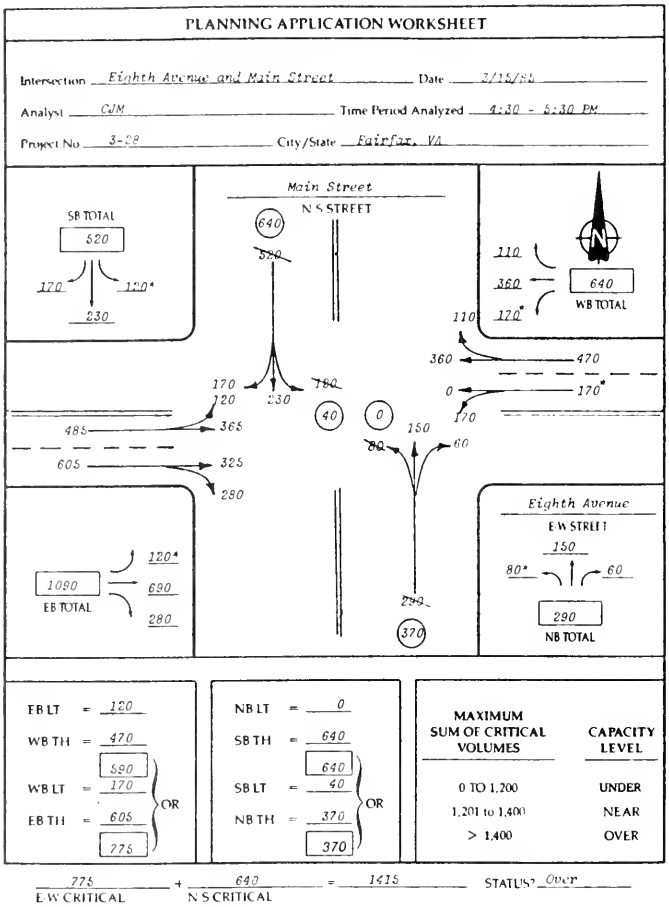


Figure 9-34. Planning analysis worksheet for Calculation 5.

g. Step 7: Check Capacity—The critical volume is checked vs. the criteria of Table 9-14, which is also shown in the bottom right-hand corner of Figure 9-34. It is seen that this intersection will probably be *over* capacity, and will be subject to breakdowns during the study period unless improvements to capacity are made. Given the volume of left-turn movements, separate left-turn lanes might be considered for each approach, subject to physical constraints.

CALCULATION 6—DETERMINING *v/c* AND SERVICE FLOW RATES, AN ALTERNATIVE USE OF THE OPERATIONAL ANALYSIS PROCEDURE

1. *Description*—A two-lane through movement at one approach to a signalized intersection has a cycle length of 90 sec, with a g/C ratio of 0.50. The arrival type is currently 3 (random), but could be improved by altering the progression. What is the maximum service flow rate that could be accommodated at level-of-service B (15 sec/veh of delay) on this approach?

2. *Solution*—Delay is based on the v/c ratio, X; the green ratio, g/C, the cycle length, C; the lane group capacity, c; and the progression factor, PF. The latter value may be computed as the saturation flow rate for the lane group times the g/C ratio which is known. Assume that a standard analysis using the Saturation Flow Adjustment Worksheet has been conducted, and that the saturation flow rate for the lane group is found to be 3,200 vphg, and the capacity $3{,}200 \times 0.50 = 1{,}600$ vph.

If delay is set at 15.0 sec/veh, and the known values of C, g/C, and c are inserted into Eq. 9-18, the following relationship is established:

$$15.0 = (d_1 + d_2)\,\mathrm{PF}$$

$$d_1 = 0.38(90)\,(1 - 0.50)^2/(1 - 0.50X)$$

$$d_2 = 173\,X^2\left[(X - 1) + \sqrt{(X-1)^2 + (16X/1{,}600)}\right]$$

Various combinations of PF (based on arrival type) and X may now be solved for, which result in 15.0 sec of delay. If the

APPENDIX C

WATER MAIN SAMPLE PHOTOGRAPHS (EXAMPLES OF DETERIORATION)

APPENDIX C

WATER MAIN SAMPLE PHOTOGRAPHS

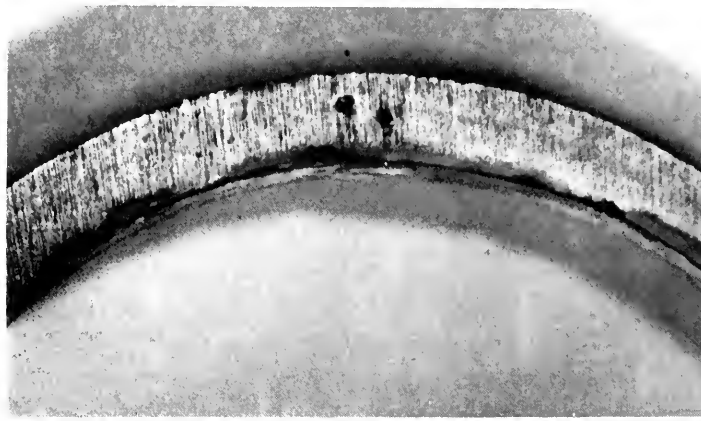
The figures contained in this Appendix serve to illustrate various factors leading to water main deterioration as described in Chapter 3. By studying pipe samples from active mains such as shown in the attached Figures, public work's staff can pinpoint the most frequent types of problems associated with main failures.

A key factor in determining the remaining life of a water main is to determine the effective wall thickness. Air inclusion in the molten metal inside pipe molds during manufacturing of water mains results in pipe walls similar to those shown in Figures 1 and 2. These samples were cut from mains manufactured in the early 1800's. These mains are more susceptible to failure because of the non-uniformity of the pipe walls.

Figure 2 illustrates several concepts associated with main deterioration. The internal wall has undergone graphitization, a process which leaches iron from the pipe leaving behind graphite. The external wall has also undergone graphitization but to a much lesser degree. The inherent strength of this main lies in the light colored metal area. The dark graphitic area has essentially no strength which makes the main more susceptible to failure at those points. Air inclusions can also be seen in this pipe sample.

Figures 3 and 4 illustrate graphitization of the external pipe wall and tuberculation respectively. The majority of the sample in Figure 3 has lost its iron content. Only the "shiny" area of this pipe is strong enough to withstand the applied forces. Figure 4 shows the results of growth of tubercules over a long period of time. This condition will severely effect water quality.

The pipe sample seen in Figure 5 demonstrates several problems described in Chapter 3. The uneven wall thickness of the pipe was introduced during manufacturing. This main broke at its weakest point where the thickness of the wall is minimized, (lower right quadrant). A crack also exists in the top center of the pipe. Both internal and external graphitization can be seen. The micrometer is used to measure the thickness of pipe lost to graphitization. Only the "shiny area" of the pipe has enough strength to withstand stress.

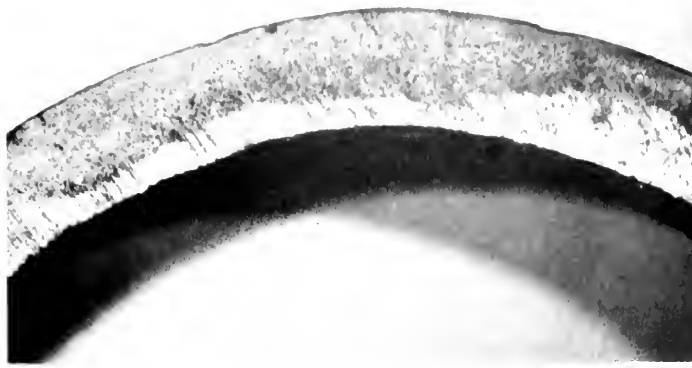


Academy of Natural Sciences/DER

Figure 1. Samples of pipe containing air inclusions caused by manufacturing technique.

Academy of Natural Sciences/DER

Figure 2. Pipe sample with combination of air inclusions and internal graphitization.



Academy of Natural Sciences/DER

Figure 3. Cross section of pipe wall exhibits graphitization (dull gray area) over 50% of wall thickness.

Academy of Natural Sciences/DER

Figure 4. Cross section of main suffering tuberculation. The buildup of corrosion products on the walls severely restricts water flow.

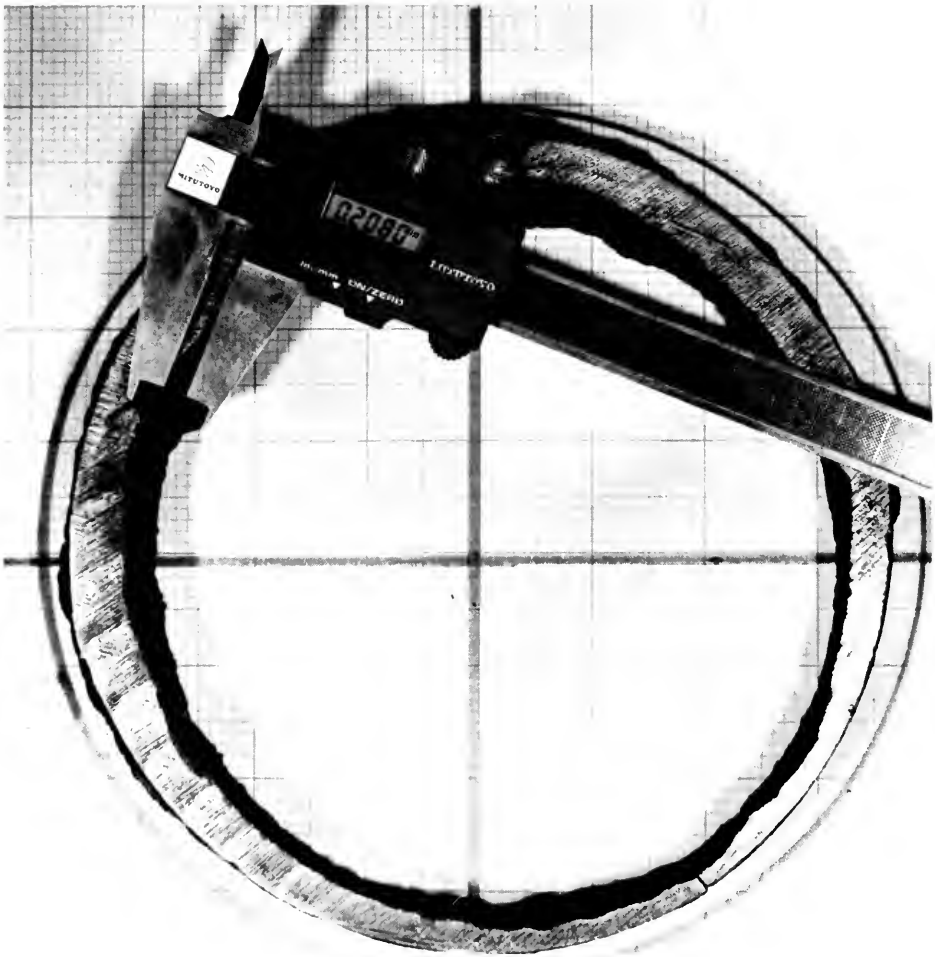


Figure 5. Micrometer measuring loss of effective wall thickness due to graphitization. Wall thickness of the pipe varies dramatically between quadrants.

Figure 6: Graphitized Cast Iron Pipe with Hole blown out by water pressure.

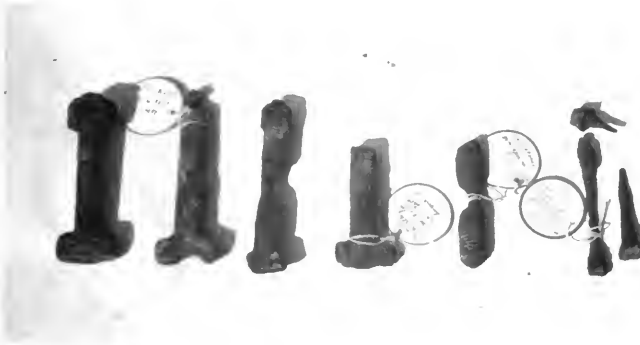


Figure 7: Stages of galvanized bolt deterioration, from new M.J. Bolt at left to pencil thin remnant on right.

Figure 8: Remnants of Galvanized Tapping Saddles as compared to new double strap bronze saddle.

Figure 9: Example of Galvanic Corrosion. See galvanized reducing streelell corroded by contact to bronze valve body.

APPENDIX D

INTEREST

TABLE

CAPITAL RECOVERY FACTORS

FOR ECONOMIC ANALYSIS

N (Years)	Interest Rate (i), = %								
	4	5	6	7	8	9	10	12	
5	.2246	.2310	.2374	.2439	.2505	.2571	.2638	.2774	
10	.1233	.1295	.1359	.1424	.1490	.1558	.1628	.1770	
15	.0899	.0963	.1030	.1098	.1168	.1241	.1315	.1468	
20	.0736	.0803	.0872	.0944	.1019	.1096	.1175	.1339	
25	.0640	.0710	.0782	.0858	.0937	.1018	.1102	.1275	
30	.0578	.0651	.0727	.0806	.0888	.0973	.1061	.1241	

APPENDIX E

CASE STUDIES ON WATER MAIN PRIORITIZATION METHODS

APPENDIX E

CASE STUDIES ON WATER MAIN PRIORITIZATION METHODS

CASE STUDIES

This subsection outlines three distribution system planning approaches which have been developed for rehabilitation decision-making. Two of these approaches (Denver and Louisville) are operational while the other one (East Bay Municipal Utilities District) is currently under development. All three approaches, however, may be implemented manually for those utilities without computer operations. Small towns have more simple systems than larger communities, yet can apply some lessons learned by larger utilities and described in this Appendix.

The Denver Water Department

The Denver Water Department (DWD) has an integrated replacement and hydraulic improvement planning approach. The overall system incorporates evaluation of main replacement needs based upon leak and break history, and distribution system hydraulic improvements needs based upon hydraulic analysis of the water distribution system.

The DWD has an overall objective of replacing 108-120 thousand linear feet of water main per year by Departmental construction crews. Approximately 30,000 feet or 25 percent of the overall replacement is directed toward replacing mains which have experienced serious corrosion. The remaining 75 percent of the replacement is directed towards improving hydraulic characteristics of the distribution system. Both replacement planning components are discussed below.

Corrosion Replacement Planning --

The replacement planning system is built around the logging and recording of all leak and break information so that assessments of frequently failing mains can be made. A number of forms are filled out by repair crews which are then utilized by the DWD in its water main replacement evaluation process.

All customer complaints are recorded on a Service and Leak Report Form. This form is used to record information on the condition related to a reported leak or break. Work orders are used to track all labor, material, equipment expenses related to repair of major leaks and breaks.

As part of leak or break repair, the repair crew completes a Leak and Service Interruption Report which identifies the apparent cause of the leak at the time of service interruption, type of customer affected, material required, personnel required and the location of hydrants out of service. On many breaks, Corrosion Engineering Company prepares a Leak Inspection Report.

Once all repairs are made, and the appropriate forms are complete, they are filed by street address and date in a central filing system. As part of the filing activity, Corrosion Engineering Company updates a wall map which includes the locations of all leaks and breaks. During the map update step, evaluation is made on the frequency of reported leaks and breaks. As a guide, mains with more than three leaks per 600 feet are identified for replacement evaluation. The Main Replacement Recommendation Form is used to evaluate replacement needs for those candidate mains.

Distribution System Improvements --

The Denver Water Department routinely evaluates the water distribution system to identify mains which need to be improved for hydraulic reasons. The distribution maps are reviewed to identify specific projects such as dead-ends, low pressure complaint areas, and areas with a sufficient fluctuation in pressure. In addition, those areas in the system which have the greatest head loss are identified for evaluation of the need for either cement lining of unlined mains or replacement of these mains. The department does approximately 40 hydraulic studies per year. The individual hydraulic studies require several weeks per study. The length of main involved in these studies can vary from 50 to 3,000 feet.

The Distribution System Improvement Form is used to assign point scores for all mains evaluated for distribution system improvement.

Annual Improvement and Replacement Plan --

On an annual basis, the Department staff reviews both the Main Replacement Recommendations and the Distribution System Improvements Recommendations to develop an overall plan for the upcoming year. The following sequence is followed during this annual review.

1. Update construction activity which has occurred during the previous calendar year.

2. Review candidates submitted for main replacement due to corrosion and for hydraulic distribution system improvements.

3. Separate candidates into corrosion, hydraulic, and joint corrosion/hydraulic replacement candidate lists.

4. Arrange candidates by point values.

5. Cut-off list of 10 points for hydraulic replacement, and 13 points for joint hydraulic and corrosion replacement.

6. Prepare preliminary list of upcoming replacement candidates.

7. Arrange special jobs based upon scheduling requirements such as paving and other utility construction.

8. Management review of preliminary list.

9. Prepare final list by construction district.

10. Construction schedule of work.

The main replacement evaluation factors and point scores are listed in Table 1A. A score of ten points is justification for recommended replacement. Once a main has been recommended for replacement, it will remain on the list of replacement candidates until it is actually replaced.

TABLE 1A

DWD CRITERIA FOR REPLACEMENT OF 12-INCH AND SMALLER MAINS

Considerations	Points
General Considerations	
Age of Main	
1. Over 80 years old	4 pts.
2. 51-80 years old	3 pts.
3. 21-50 years old	1 pt.
4. 0 - 20 years old	0 pts.
History of Leaks and Breaks	
1. minimum 2/yr or 3 in 5 yrs.	2 pts/leak or break
Depth of Mains	
1. Divergence from the standard depth	5 pts.
Hydraulic Considerations	
Divergence from Standard Grid Diameter	
1. Three or more sizes	3 pts.
2. Two sizes	2 pts.
3. One size	1 pt.
Small Size Main	
1. 4" main serving fire hydrant	4 pts.
2. 2" or smaller main	3 pts.
3. 3" main	2 pts.
4. 4" main	1 pts.
Carrying Capacity (Hazen-Williams "C")	
1. Less than 70	4 pts.
2. 70 - 79	3 pts.
3. 80 - 89	2 pts.
4. Over 90	1 pt.
Corrosion Considerations	
Corrosion of Main (5" running length)	
1. Pits >75% or wall thickness	5 pts.
2. Pits 50-75% of wall thickness	3 pts.
3. Pits <50% if wall thickness	0 pts.
Soil Resistance in ohm/cm	
1. Less than 1000	3 pts.
2. 1000 - 2000	1 pts.
3. Over 2000	0 pts.

Galvanized Pipe

Special Considerations

Pressure in Area

1. Less than 40 psi	4 pts.
2. Over 40 psi	0 pts.

Pressure Fluctuations in Surrounding Area

1. 50 psi	8 pts.
2. 40 psi	5 pts.
3. 30 psi	3 pts
4. 20 psi	1 pt.

Pressure Zone Boundary Change To Be Made

1. 6 months	8 pts.
2. One Year	4 pts.

The Louisville Water Company

The Louisville Water Company (LWC) has established a long-term goal of rehabilitating or replacing all pre-1937 unlined cast iron mains, estimated to total 600 miles in length. This policy decision is based solely upon the serious break and water quality problems presented by these mains, not on any economic justification.

The replacement evaluation plan developed by the LWC uses data derived from emergency and maintenance work tickets, distribution system maps, and field test reports which are stored in both computer data bases and in paper files. LWC has computerized files for all breaks since 1962, leaks and red water complaints since 1972, and fire flow test results since 1980. In addition, LWC has a computer file of all main extensions in their service area.

The computerized break and leak history data base for each main is used to identify potential main replacement candidates. Mains can also be pinpointed for evaluation based on visual inspection which takes place in areas under construction or development. In total, LWC's planning system uses five water main data files and special referrals to identify potential main replacement candidates.

All main replacement candidates are evaluated using the Main Replacement Evaluation form. This evaluation form includes 15 factors, each with a relative weight designed so that the maximum potential score is 1,000 points. A score of 400 is considered justification for replacement pending subjective judgement. The factors and their relative weights are summarized in Table 6. When the form is completed, the data is keyed into the Main Replacement Evaluation data file which is used in tabulating the point scores and sorting the replacement candidates by computer.

TABLE 2A

LWC REPLACEMENT EVALUATION FACTORS

Factor	Relative Weight
1. Central Business District (Y/N)	5%
2. Redevelopment Zone (Y/N)	20
3. Main Size	20
4. Roadway Classification	4
5. Main Break Data	5
6. Joint Leak Data	5
7. Field Pipe Samples	5
8. High Maintenance Priority	10
9. Fire Flow Availability	5
10. Red Water Data	5
11. Documented Water Availability Data	10
12. Corrosive Soil Zone	N/A
13. Dead End Main	2
14. Age/Type Main	2
15. Type Joint	2
	100%

The Main Replacement Evaluation data file contains 600 replacement candidates to date. The LWC has used this approach for several years. LWC management plays an important role in setting the relative weights to ensure that the replacement program follows the Company's policy direction. Louisville's planning system includes extensive management review in establishing policy guidelines, budget allocations, review of candidate lists, setting of priorities by zone, and selecting recommended mains for Board approval.

The East Bay Municipal Utility District

The East Bay MUD has developed a two part cost/benefit analysis approach for deciding when a small main should be replaced. Primary factors included in this analysis are summarized in Table 3A. This first part is a simple economic model which will give an estimated dollar value for the cost of maintaining the main through repairs and the cost of replacing the main. If the cost of repairing the main is higher than the cost of replacing it, the main is considered for replacement. The benefit analysis entails subjective judgement of those factors which must be considered but cannot be quantified with a dollar value.

TABLE 3A

EBMUD PROPOSED PIPELINE REPLACEMENT CRITERIA

Cost Analysis

annual cost of maintaining the existing main
present cost of installing a replacement main
estimated rate of return on invested capital

Benefit Analysis

Distribution System Benefits
-- improved distribution flows in the immediate area
-- increased operational flexibility throughout the network
-- improved fire protection
-- improved quality of water
-- reduced pumping costs
-- reduced cost of service improvements when required by street resurfacing

Other Benefits
-- improved public relations
-- elimination or reduction of liability for damage claims arising from a ruptured main

In order to select candidate mains for economic analysis, East Bay MUD relies upon its leak repair and damage reports. Leaks are plotted on a leak map and high leak mains are noted. Break trends for each main are plotted on a repair chart. Based upon these break trend plots, candidates are elected. To perform the two part economic analysis, a pipe replacement economics and pipe replacement benefits forms is filled out for each candidate main. East Bay MUD attempts to estimate the dollar value of all replacement benefits identified for each main. For mains selected for replacement based upon this analysis, a pipe replacement summary form is prepared.

The decision to repair or replace a given main is the responsibility of a committee consisting of members representing various perspectives within the East Bay MUD. The committee decides the relative importance of each evaluation factor for each individual main replacement candidate rather than having a formalized point score system. The committee's decision will change to reflect the utility's current policy on economic and operational efficiency.

TABLE 3.2

CRITERIA FOR MAIN REPLACEMENT EVALUATIONS

Factors	Community One	Community Two	Community Three
Main Characteristics			
Age		X	X
Size		X	X
Depth		X	
Corrosion		X	X
Dead End Main			X
Type of Material or Joint		X	X
Break/Leak History	X	X	X
System Characteristics			
Water Quality	X		X
Water Pressure	X	X	X
Operational Flexibility	X		
Reduced Pumping Costs	X	X	
Secondary Reinforcing Main Increased Carrying Capacity	X	X	
Area Characteristics			
Soil Data		X	X
Electrolysis			
High Priority Zone **	X		X
Development Zone ***	X	X	X
Cost Analysis			
Cost of Maintaining	X		
Cost of Replacing	X		
Rate of Return on Invest.	X		

** Areas such as the Central Business District, busy highways, and other highly visible areas affecting public relations, and areas which would sustain much damage in the event of a ruptured water main resulting in expensive damage claim.

*** Areas where construction will or is taking place such as redevelopment areas, new development areas, and road resurfacing projects.

APPENDIX F

HYDRANT FLOW TESTS

APPENDIX F

HYDRANT FLOW TESTS

Materials Required:

* 1 static pressure gauge for attachment to a hydrant streamer nozzle (usually 2-1/2 inches), available from Montana suppliers

* 1 pitot gauge for clamping to an opening on a streamer nozzle, also available from Montana suppliers

* flow test forms as follows

PROCEDURE:

Follow the procedures as outlined on the succeeding page, with the pitot gauge attached to the flow hydrant and the static pressure gauge attached to the closest upstream hydrant.

Care should be taken to flow the hydrants until the water is clear, to notify affected residents of potential short term turbidity problems, to open hydrants fully to prevent drain valve leakage, and to shut hydrants slowly to prevent water hammer.

FLOW HYDT(S) _____

TEST POINT _____

DATE		
AVAIL @ 20		
AVAIL @ ___		

SKETCH

N

EXPLANATION

The water flow chart on the opposite site of this sheet is a semiexponential scale that has been developed to simplify the process of determining available water in an area. The chart is accurate to a reasonable degree, if one uses a fine point pencil or pen when plotting results. The figures on the vertical and/or horizontal scales may be multiplied or divided by any constant, as may be necessary to fit any problem.

For example, if a static pressure is recorded that exceeds 70 psig, the vertical pressure scale can be changed to read 10, 20, 30 and up to 150 psig. Also, if a total discharge during a test was less than 1,000 gpm, it would be exceedingly difficult to use the top scale on the horizontal water flow. When flows of low volume exist, the lower or middle scale should be used.

PROCEDURE

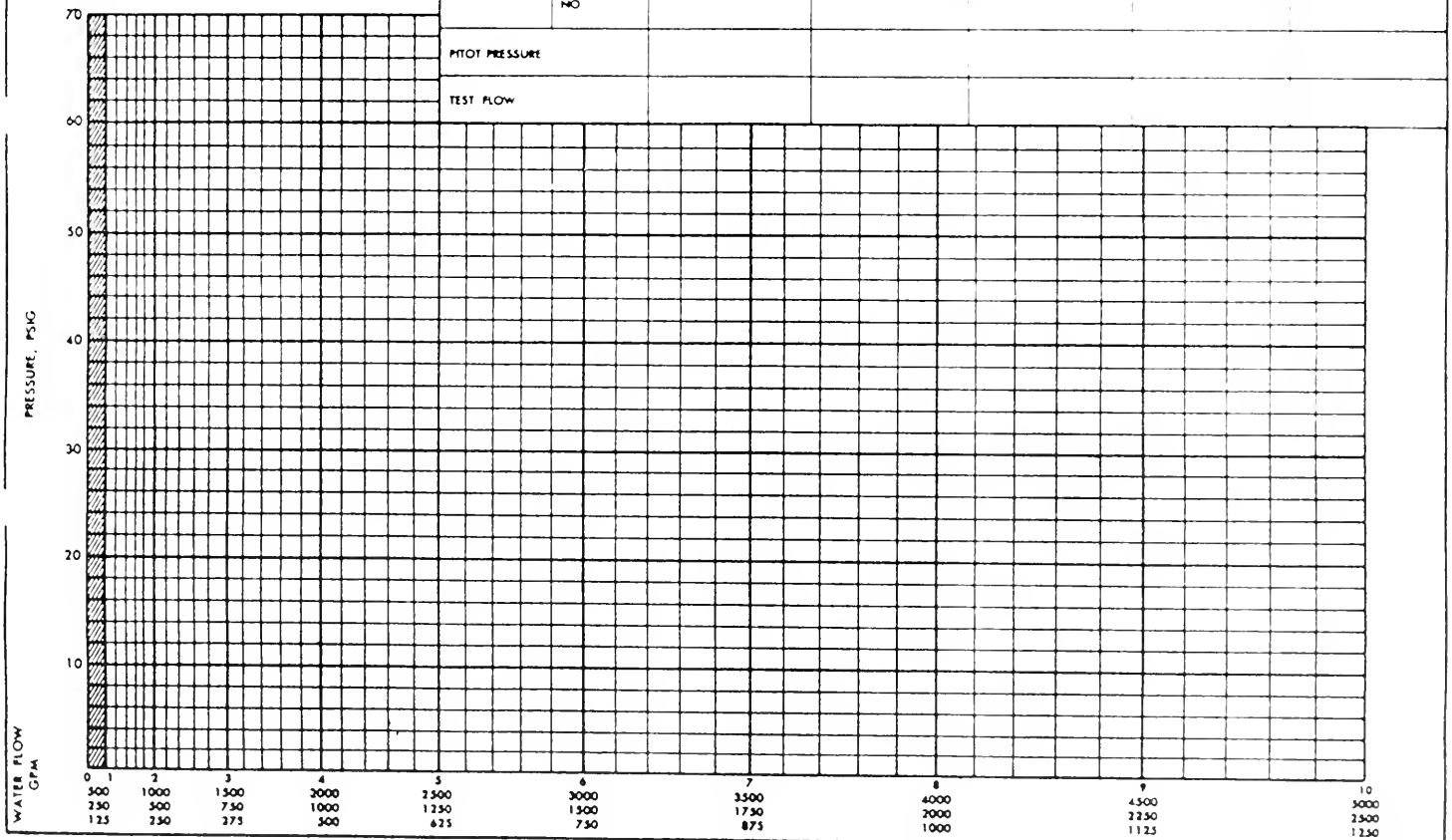
1. Observe and record the static pressure at the test hydrant.
2. Open the flow hydrant(s), let the system pressure stabilize for about 15 seconds, take pitot pressure of the water stream(s) and record the readings. During the flow, observe and record the stabilized residual pressure at the test hydrant.
3. Slowly shut down the hydrant. Verify that the static pressure at the test hydrant has returned to the value in Step 1.
4. Compute the flow rate (gpm) during the test and record.
5. On the left border of the flow test record, place a mark at the static pressure observed in Step 1.
6. Place a mark at the intersection of the residual pressure (vertical scale) and the test flow gpm (horizontal scale).
7. Draw a straight line from the static pressure point (Step 1) through the residual pressure point (Step 6). Extend the line to the right to the limits of the chart.
8. This line represents the theoretical water pressure available at the test hydrant for any flow at that hydrant.

WATER FLOW TEST RECORD

(See sketch and procedure on reverse)

DATE						
STATIC PRESSURE						
RESIDUAL PRESSURE						
OUTLET	SIZE					
	NO					
PITOT PRESSURE						
TEST FLOW						

LOCATION



APPENDIX G

PUMP CURVE DEVELOPMENT

APPENDIX G

PUMP CURVE DEVELOPMENT

PROCEDURE:

1. Install a metering device, or segregate a down line storage tank on the discharge side of the pump. The storage tank, with a defined volume per inch, will serve as a measuring device by calculating volume change over a period of time.

2. Dedicate and segregate the discharge line from the pump to the flow measuring device (or tank).

3. Install pressure gauges on suction and discharge sides of the pump. Use high quality liquid filled gauges calibrated to 1 P.S.I.

4. Install (or utilize existing) a pump discharge valve to vary discharge head.

5. Start the pump, and with the discharge valve fully open, read the gauges, the flow measuring device (which may be by "dipping" the tank to determine water surface elevation), and run the pump for a period to obtain another reliable volume (or flow) measurement. Record the flow (or volume) change, the elapsed change, and any change in pressure readings. Note, that suction head may also be determined by physical measurement from the centerline of the pump volume to a wet well level.

6. Throttle the discharge valve to produce a 5 P.S.I. change in discharge head and repeat step 5 above.

7. Repeat the process until shutoff head is reached.

8. Plot the results on a Q (flow) vs. H (head) curve, compare to original.

9. See the attached sample pump curve data form.

Calcualtion of Q is as follows:

$$Q = \frac{\text{final meter reading - original meter reading}}{\text{elapsed time}}$$

Note:

(1) If meter readings are in gallons, no correction is necessary.
If meter readings are in cubic feet, divide such by 7.48 to obtain gallons.

(2) For cylindrical tanks, the volume filled over the elapsed time period is:

Vol. (in cubic feet) = r (h - h)

Where = 3.14

r = tank radius
h = final tank level reading
h = initial tank level reading

APPENDIX H

WIRE TO WATER
PUMP EFFICIENCY AND PUMPING COST CALCULATIONS

APPENDIX H

WIRE TO WATER
PUMP EFFICIENCY AND PUMPING COST
CALCULATIONS

To save money and prevent problems, pump efficiency should be as high as possible. Efficiencies below the curve originally supplied with the pump indicate a problem.

Basic factors affecting energy costs are energy sources (electricity, gas, or diesel), system efficiencies, and functional modifications initiated to improve efficiencies.

Pumps should be monitored for efficiency, so that corrective action may be taken to improve efficiencies as required. Items that may be considered in C.I.P. planning are:

1. scheduled maintenance efforts
2. component retrofit (packing glands, etc.)
3. variable speed drives
4. high efficiency motors (replacement of low efficiency units)
5. functional modifications
    a. off-peak scheduling
    b. head reduction
    c. volume reduction (conservation)

Electricity is the most common and generally least costly energy source. On occasion, rural pump settings may use diesel, propane, or gas due to the high cost of 3-phase power extension. Non-electric pumps do provide standby capability during electrical outages.

Following are calculations from Vol. 1 of the DNRC booklet - "Energy Auditing in Water and Wastewater Treatment Systems" which illustrate examples of pump and wire-to-water efficiencies.

BASIC PUMPING FACTS

FUNCTION OF PUMP: TO DEVELOP A GIVEN RATE OF FLOW OF WATER ACROSS A GIVEN PRESSURE (OR HEAD) DIFFERENTIAL.

BASIC PUMP EQUATION: $BHP = \frac{QH}{3960\,Ep}$ WHERE,

- BHP = BRAKE HP TO DRIVE IMPELLER SHAFT
- Q = DISCHARGE IN GALS/MIN
- H = HEAD ACROSS PUMP IN FEET
- Ep = PUMP EFFICIENCY

BASIC MOTOR EQUATION

(SINGLE PHASE): $P = EI\,(PF)$ WHERE,

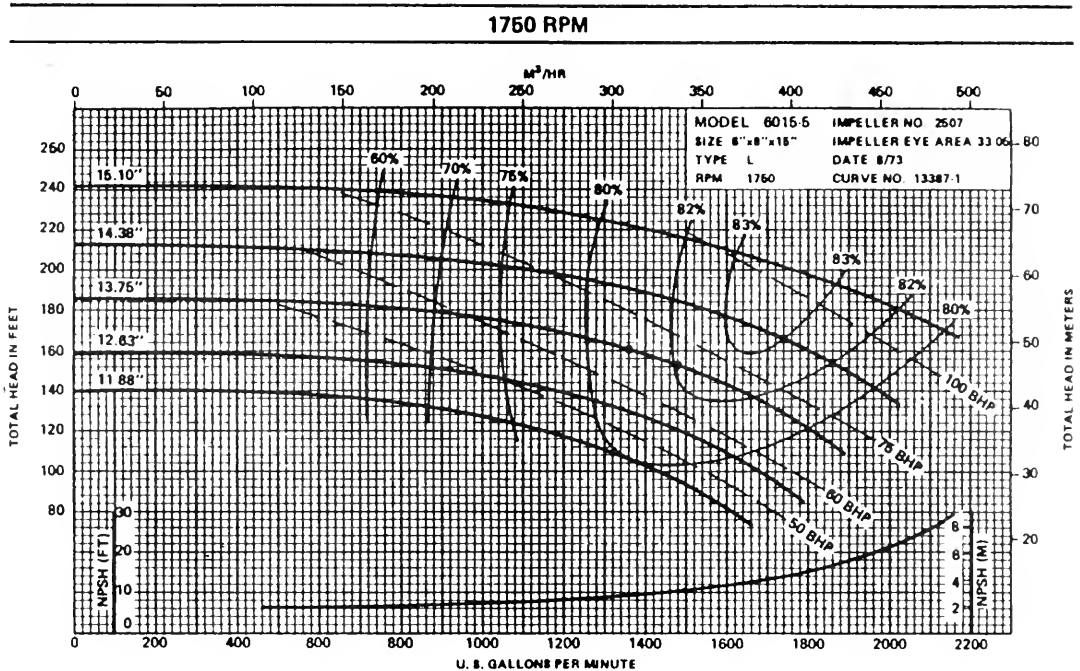
- P = ELECTRICITY INPUT IN WATTS
- E = VOLTAGE
- I = CURRENT IN AMPERES
- PF = POWER FACTOR OF MOTOR

(THREE PHASE): $P = \sqrt{3}\ EI\,(PF)$

WIRE-TO-WATER EQUATION: $KW = \frac{QH}{5308\,EmEp}$ WHERE,

- KW = KILOWATT INPUT TO MOTOR
- Em = MOTOR EFFICIENCY

TYPICAL CENTRIFUGAL PUMP CURVE



PUMPING AND STORAGE EXAMPLE

(Refer to Pump Curve)

- HIGH SERVICE PUMP NORMALLY OPERATES AT:
  - 160' TDH
  - 1360 GPM
  - 68 HP
  - .87 MOTOR EFFICIENCY

  PUMP EFFICIENCY = 81%

- LOWER STORAGE TANK OPERATING LEVEL BY 8 FT:
  - 152' TDH
  - 1480 GPM
  - 69 HP
  - .87 MOTOR EFFICIENCY

  PUMP EFFICIENCY = 82%

- FOR 1 MGD SYSTEM, COMPARE COSTS:

$$68\ HP \times \frac{1}{.87} \times .746\ KW/HP \times 12.25\ HRS/DAY \times 365\ DAYS/YR \times \$.07/KWH = \$18,250/YR$$

$$69\ HP \times \frac{1}{.87} \times .746\ KW/HP \times 11.25\ HRS/DAY \times 365\ DAYS/YR \times \$.07/KWH = \$17,006/YR$$

• SAVINGS = $1,244/YR

SAMPLE PROBLEM 1

Improvement in Pump Efficiency

Determine what the new pump operating point (head/capacity) would be if the impeller were shaved to provide optimum efficiency at fixed conditions of head.

Existing Conditions:

Impeller Curve		=	14.38 inches
Operating Point	Q	=	1800 gpm
	TDH	=	160 ft
	Efficiency	=	82.5%

New Conditions:

Impeller Curve		=	_____ (approx.)
Operating Point	Q	=	_____ gpm
	TDH	=	_____ ft
	Efficiency	=	_____ %

DETERMINING ACTUAL PUMP EFFICIENCY

$$Ep = \frac{3.14\,HV}{PEm}$$

WHERE

Ep	=	PUMP EFFICIENCY
H	=	HEAD IN FT
V	=	FLOW QUANTITY IN MILLIONS OF GALLONS
P	=	POWER CONSUMPTION IN KWHR
Em	=	MOTOR EFFICIENCY

PARAMETER	HOW TO MEASURE
• HEAD	– PRESSURE GAGES – CALCULATED FROM WATER ELEVATIONS
• FLOW QUANTITY	– FLOW METER/TOTALIZER – WET WELL LEVELS (VOLUME CALCULATIONS)
• POWER CONSUMPTION	– WATT METERS OR WATT-HOUR METERS CLAMP-ON AMMETER (CALCULATE)
• MOTOR EFFICIENCY	– MANUFACTURERS SPECS – ASSUMPTION

CALCULATION OF PUMP EFFICIENCY
- EXAMPLE -

A RAW SEWAGE PUMP OPERATING AT A HEAD OF 30 FEET DRAWS DOWN A 25 FT X 25 FT INFLUENT WETWELL BY 3.0 FT (WITH INFLUENT VALVE CLOSED) WHILE OPERATING FOR THREE (3) MINUTES. DURING THIS PERIOD THE CURRENT DRAW ON THE 50 HP, 460 VOLT, 3-PHASE MOTOR WAS MEASURED TO BE 63 AMPS. WHAT IS THE EFFICIENCY OF THE PUMP?

•SOLUTION:

FLOW QUANTITY = (25 FT) (25 FT) (3.0 FT) (7.48 GAL/CU FT) = 14,025 GAL

POWER CONSUMPTION = $\frac{\sqrt{3}\ (460\ V)\ (63\ A)\ (.81)}{1000}$ X .05 HR = 2.0 KWHR

$$Ep = \frac{(3.14)\ (30\ FT)\ (.014\ MILLION\ GAL)}{(2.0\ KWHR)\ (0.90)} = 0.73$$

DETERMINING WIRE-TO-WATER EFFICIENCY

- A 100% EFFICIENT PUMP/MOTOR COMBINATION WOULD REQUIRE ONE KWHR OF ELECTRICITY TO RAISE 318,200 GALLONS OF WATER ONE FOOT.

- SO –
  TO DETERMINE THE THEORETICAL GALLONAGE/KWHR FOR ANY OTHER HEAD, SIMPLY DIVIDE 318,200 BY THE HEAD INVOLVED.

- THEN –
  THE ACTUAL EFFICIENCY OF A PARTICULAR PUMP/MOTOR COMBINATION EQUALS:

$$\frac{\text{ACTUAL GALLONS/KWHR}}{\text{THEORETICAL GALLONS/KWHR}}$$

NOTE: AN EFFICIENCY BELOW 65% IS OFTEN EVIDENCE OF A PROBLEM.

CALCULATION OF WIRE-TO-WATER EFFICIENCY - EXAMPLE -

A RAW SEWAGE PUMP RAISES 16 MILLION GALLONS OF WASTEWATER AN AVERAGE OF 30 FT DURING ONE MONTH, AND CONSUMES 2125 KWHR IN THE PROCESS. WHAT IS THE COMBINED PUMP/MOTOR EFFICIENCY?

•SOLUTION:

THEORETICAL PUMPAGE AT 30 FT HEAD	=	$\frac{318,200}{30}$	=	10,607 GALS/KWHR
ACTUAL PUMPAGE	=	$\frac{16,000,000}{2125}$	=	7529 GALS/KWHR
PUMP/MOTOR EFFICIENCY	=	$\frac{7529}{10,607}$	=	71%

APPENDIX I

ACCOUNTING GUIDELINES FOR CREATION OF DEPRECIATION REPLACEMENT SCHEDULES FOR WATER SYSTEMS, SEWER SYSTEMS AND STREETS.

APPENDIX I

ACCOUNTING GUIDELINES FOR CREATION OF DEPRECIATION REPLACEMENT SCHEDULES FOR WATER SYSTEMS, SEWER SYSTEMS AND STREETS

WATER SYSTEMS

The following guidelines are recommended by Farmers Home Administration for estimating dates for replacement of major water system components. Ideally, these guidelines should be discussed with your public works director, engineer and accountant. The water needs assessment done as part of your Mini CIP may provide information that would lead you to modify the following guidelines to reflect the degree of deterioration of your water system.

The following information was developed by CPA Steve Fite for the Farmers Home Administration publication Accounting for Rural Water Systems, A Practical Approach (April 1980).

Example. Farmers Home recommends that the accountant use the "straight line" depreciation method. Straight line is where the same amount of depreciation is taken each year for the life of the facility component (asset). For example, a new pump is installed for a cost of $3,000. From the table below it is estimated that the new pump will last 10 years. The amount of straight line depreciation is $300 per year ($3000 for 10 years). Thus to replace the pump, $300 is reserved from user fees each year and placed in an earmarked fund. At year 10, the $3,000 has been accumulated and the pump needs replacement. Money is thus "in hand" to promptly replace the pump. (This is a simplified example. In reality, because of the impact of inflation and interest earnings, the depreciation schedule would be more complex than this example.)

Water System Component	Years
Office furniture & fixtures	10
Office building	40
Equipment & tools	10
Transportation equipment	5
Pumps & treatment equipment	10
Well(s)	Engineers Estimate
Dam	Engineers Estimate
Plant Buildings	40
Water lines	40
Water Storage	40

WASTEWATER SYSTEMS

The following wastewater depreciation guidelines are recommended by the depreciation experts at the Commerce Clearing House Incorporated in Chicago, Illinois. The guidelines help utility staff, engineers, and financial staff to estimate dates for replacement of wastewater system components. You should discuss these guidelines with your public works director, engineer, and accountant. The wastewater system needs assessment done as part of your Mini CIP may provide information that would lead you to modify these guidelines to reflect the degree of deterioration of your wastewater systems.

See the example under water systems. You use the wastewater depreciation table in the same basic way. For further information, see page 37 of the 1991 Depreciation Guide

(Standard Federal Tax Reports, Vol #78, #20, May 10, 1991) published by Commerce Clearing House Inc., 4025 West Peterson Ave., Chicago, Illinois, 60646.

Wastewater System Component	Years
Wastewater Treatment Plants	24
Sewer lines	50

(Note: Commerce Clearing House Inc. does not publish separate tables for local government wastewater plant buildings, office buildings, furniture, tools, and miscellaneous components. See the water system depreciation table for these components. They are easily adaptable to waste-water systems.)

STREETS AND ROADS

The following guidelines are recommended by Clete Daily Associates of Helena, Montana for the depreciation of streets and roads for repair or replacement purposes. Mr. Daily is a professional transportation engineer and street expert. The guidelines should be discussed with your public works director, engineer, and accountant. The street and road needs assessment done as part of your Mini CIP may provide information that would lead you to modify these guidelines to reflect the degree of deterioration of your street or road network.

Type of Street/Road Treatment	Years
Seal Coat (chip seal) of asphalt street or road	7
Asphalt overlay of asphalt street or road	15-20
Crack Seal (need to reseal)	1
Concrete curb and gutter	
with good base	80
with poor base (e.g. expansive clay)	20
Gravel roads (need to regrade)	1

Note: Concrete streets and roads are not included because they have been phased out. Asphalt streets and roads are the predominant type in communities while gravel roads are common in rural areas.

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